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Case Studies of Stationary Source Compliance with Houston, Texas Air Pollution Control Requirements

Booz-Allen and Hamilton, Inc.
Bethesda, MD

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CEQ and EPA sponsored five studies examining the response of sources to the regulatory approach to controlling air pollution, with emphasis on the post-compliance emissions history. The study areas are: North Carolina (3 vols), Houston (3 vols), San Diego (3 vols), Chicago (3 vols), and New Jersey (2 vols).

This report presents the results of 20 plant inspections conducted in Texas. One of the principal purposes of the plant inspections was to evaluate the effectiveness of the Houston City Agency regulatory policies with respect to the attainment and continued maintenance of regulatory emission limits.

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Case Studies of Stationary Source Compliance with Houston, Texas Air Pollution Control Requirements

JULY 1, 1979

PREPARED FOR

PRESIDENT'S COUNCIL ON ENVIRONMENTAL QUALITY

OFFICE OF PLANNING AND EVALUATION
U.S. ENVIRONMENTAL PROTECTION AGENCY

BOOZ ALLEN

4330 EAST WEST HIGHWAY
BETHESDA, MARYLAND 20014
301-951-2200

pedco

11499 OLD CHESTER ROAD
CINCINNATI, OHIO 45246
513-782-4717

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BOOZ · ALLEN & HAMILTON Inc.
Energy and Environment Division

4330 EAST WEST HIGHWAY
BETHESDA, MARYLAND 20014
951-2200
AREA CODE 301

June 29, 1979

Mr. James S. Vickery
Office of Planning and Evaluation
Room 1019-B (West Tower)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Jim:

We are pleased to submit our final report on Task II entitled "Case Studies of Stationary Source Compliance with Houston, Texas Air Pollution Control Requirements." Principal contributors to this report were Dr. Herbert J. Belknap, Dr. Gerald A. Isaacs, and Mr. Tom Ponder of PEDCo Environmental.

In preparing this report, we have taken into consideration the comments which you and Gordon had on our draft reports. Since our specific responses to those comments may not be readily apparent from a review of the report, we are forwarding a point by point response under separate cover.

We will be available to answer any questions you may have and hope to be able to assist you in the future.

Sincerely,

Alan C. Farkas

BOOZ · ALLEN & HAMILTON Inc.

Alan L. Farkas
Principal

j.a

DISCLAIMER

This report was furnished to Booz, Allen and Hamilton by PEDCo Environmental, Inc., in fulfillment of Contract No. EQ8AC 015. The opinions, findings, and conclusions expressed herein are those of the author and do not necessarily reflect the opinions of any other organization or agency.

EXECUTIVE SUMMARY

The Council on Environmental Quality and the United States Environmental Protection Agency are sponsoring five studies examining the response of sources to the regulatory approach to controlling air pollution with an emphasis on the post compliance emissions history. This report presents the results of 20 plant inspections conducted in Texas. One of the principal purposes of the plant inspections was to evaluate the effectiveness of the Houston City Agency regulatory policies with respect to the attainment and continued maintenance of regulatory emission limits.

It was found in this study that significant reductions in air pollutant emissions have been achieved in the Houston area in the past five to eight years. This is shown in the majority of the source emission profiles. This was accomplished by the adoption of more stringent regulations by the Texas Air Control Board in the early 1970's and by the local and regional regulatory agencies carrying out a diligent enforcement policy. Most of the sources in this study are under nearly constant surveillance by the Texas Air Control Board, the City of Houston Health Department, and the Harris County Pollution Control Department. Naturally it was the cooperation of the sources in spending large sums of money for the installation and maintenance of the air pollution control equipment that effected this reduction in emissions.

In some cases court action by the regulatory agencies was necessary to force sources to install the proper control equipment, while in other cases voluntary source compliance was observed. By and large, it appears that most of the sources that we investigated are doing a relatively good job of maintaining emissions below legal limits. However, there were exceptional cases in which sources were operating continuously above those limits. A principal weakness noted was that the sources were not considered to be in violation of the law during upset conditions if the company reports the upset to the regulatory agencies (TACB Rules 7 and 8). It appears that several of the companies take advantage of this provision to the point of abusing it. Some of the sources report upset conditions practically on a daily basis instead of maintaining their control equipment to be able to avoid excursions above legal emission limits.

In a number of cases the sources emitted considerably less than the legal allowable amount. This reflects good design and good operation/maintenance practices. "Emission credits" have been calculated so that these sources can be properly recognized. Over all the study sources there were significantly more emission credits than excess emissions.

ACKNOWLEDGMENTS

This report was prepared for Booz, Allen & Hamilton. PEDCo Environmental sincerely appreciates the assistance and guidance provided by Mr. Alan Farkas and Mr. Barry Russell of Booz, Allen & Hamilton. Appreciation is also expressed to the industry personnel and personnel from the state and city agencies who provided information and assistance in this project.

The PEDCo project director was Mr. Tim Devitt. The project manager of the combined North Carolina and Houston, Texas, studies was Dr. Gerald A. Isaacs. The principal investigator for the Texas study was Dr. Herbert J. Belknap. Authors of this report were Dr. Herbert J. Belknap and Dr. Gerald A. Isaacs.

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1. IDENTIFICATION OF STATIONARY SOURCE CASE STUDIES

1.1 Selection Criteria

The scope of the study was limited to 16 industrial categories which are listed in Table 1-1. The approximate number of companies available for study in Houston is shown in the table based on a listing by the City of Houston Health Department. This is not an exhaustive list, but does represent the majority of companies in each category available.

The CEQ and the EPA proposed an extensive list of criteria to be used in the selection of stationary sources. These are shown in Table 1-2. In addition to fulfilling these requirements, half of the group was to have achieved compliance at one time and was to have had subsequent difficulty in maintaining compliance. The remaining half of the group was to be chosen randomly.

We have attempted to emphasize the most important items in Table 1-2, as we understand them.

- The availability of useful data (Item 2)
- Distribution of source type (Item 6)
- Distribution of control techniques (Item 9a)
- Distribution of potential uncontrolled emissions (Item 4)
- Source cooperation (Item 3)
- Distribution of type of pollutants emitted (among TSP, SO_2, HC)
- Distribution of sources according to size of operation (Item 5)

Using the CEQ/EPA source selection criteria the Houston city agency personnel compiled a list of 44 candidate companies from their computer files that met the criteria. From this list 29 candidate companies with 38 possible sources were selected by PEDCo. Consideration was given to more than one source at a large facility because of:

- High probability of finding hard emission data
- High probability of large potential uncontrolled emissions
- Heavy air pollution control expenditures
- A high degree of control technology.

The Houston study was limited to the geographical area within the Houston city limits and the area along the Houston Ship Channel that is within the surveillance territory of the Houston city agency. This area extends outward 2500 feet from the center of the channel on both sides. Other candidate sources just outside the Houston city agency jurisdiction were not considered.

TABLE 1-1

NUMBER OF SOURCES AVAILABLE FOR STUDY IN HOUSTON, TEXAS AND ALONG THE HOUSTON SHIP CHANNEL

	Source Categories	Approximate Number of Sources
1.	Steam Generating Plants (Utility and Industrial) All natural gas fired - No significant emissions of HC, Particulates, SO_2	None
2.	Pulp and Paper Mills	3
3.	Incinerators	1
4.	Petroleum Refining	6
5.	Cement Plants	3
6.	Asphalt Plants	6
7.	Mineral Acid PLants	2
8.	Iron and Steel Plants	4
9.	Aluminum Plants	5
10.	Brass and Bronze Plants	5
11.	Petrochemical Plants	14
12.	Stone, Clay and Glass Plants	4
13.	Grain Handling Operations	15
14.	Fertilizer Plants	9
15.	Lumber and Wood Products Plants	5
16.	Surface Coating Operations	8

TABLE 1-2
CEQ/EPA SOURCE SELECTION CRITERIA

1. Near equal distribution of sources of following pollutants: TSP, SO_x, HC.

2. All sources are data rich, i.e., have hard emission data available.

3. All sources are willing to participate in study.

4. Near equal distribution of sources according to uncontrolled emission levels in excess of 25 ton/yr.

5. Near equal distribution of sources according to size of operation, but employing no fewer than 50 people.

6. Near equal distribution of sources across categories on identification list (see Table 1-1).

7. Near equal distribution of sources according to ages of process and control system equipment.

8. Near equal distribution of sources according to types of corporate structure, i.e., publicly held corporation, private corporation, publicly owned utility.

9. Consideration for maximizing the variation in:

   a) Types of control systems to be studied,
   b) Levels of required control, i.e., collection efficiency, and
   c) Levels of capital and operating costs in order to achieve desired control.

1.2 Selection Procedures

This project was introduced to the Houston city agency by Mr. Jim Vickery, EPA and Mr. Gordon Brady, CEQ on August 9, 1978 at the city agency offices. Subsequently using the CEQ/EPA source selective criteria the city agency prepared a list of 44 candidate companies that met the selection criteria.

To select the candidate sources to be visited, PEDCo first reviewed the files in the Enforcement Division of the Texas Air Control Board (TACB) offices in Austin. Next the files were reviewed at the TACB Region 7 office in Houston. Time requirements for this review were 1 to 4 hours for each source. PEDCo's representatives were denied an open review of the city agency files, which were regarded to be confidential by the city agency. A preliminary list of sources was selected containing 29 companies and 38 sources. This list was submitted to Mr. Alan Farkas and Mr. Jim Vickery on September 28, 1978 for approval. The list was approved after it was reduced to 27 companies and 34 sources, with no more than two sources at any one company.

In the course of this study 20 sources on the approved list were visited and studied. Table 1-3 characterizes the 20 sources. In this table the source category number corresponds to the industries listed in Table 1-1. The principal pollutant that is controlled by the control equipment is listed in the third column. In many cases there are other pollutants in the exhaust gas that are not regulated by the TACB. The types of control techniques, given in the next column, indicate considerable variety. The other columns in the table show a wide range in the sizes of equipment and in uncontrolled emissions. Capital cost of the last installed control equipment and annual maintenance are given also.

It may be noted that there are only two sources on this list that control SO_2 and only one that controls hydrocarbons. The reasons for the lack of SO_2 sources is that natural gas is used as fuel in this area almost exclusively. The other reason is that the TACB regulations are source specific for SO_2 emissions; thus not all SO_2 emissions are controlled. The reason for the low number of hydrocarbon sources is the lack of emission data for hydrocarbons. The principal potential hydrocarbon emissions are from large storage tanks. The control method is a floating roof with either outside or inside seals. The control technique is specified by the design of the floating roof, and compliance tests are not usually made. Thus it is rather difficult to evaluate the control equipment. Also waste hydrocarbons from petrochemical manufacturing processes are frequently burned as fuel in a boiler. These waste fuel boilers are operated such that the hydrocarbons are consumed almost completely. Only in a few cases is the hydrocarbon content of the waste gas low enough

TABLE 1-3. CHARACTERISTICS OF STATIONARY SOURCES INCLUDED IN THE STUDY

Source number	Industry* type	Principal pollutant	Control technique	Age yrs	Gas flow rate acfm	Uncontrolled emissions ton/year	Capital cost $(000)	Annual maintenance cost $(000)
21	2	Part.	ESP	5	5.0×10^5	1.7×10^5	3600	930
22	2	SO_2	Scrubber	4	5.0×10^3	7.0×10^2	--	--
23	4	Part.	Cyclone	2	1.0×10^5	1.7×10^3	200	NA
24	4	Part.	ESP	8	4.1×10^5	1.3×10^3	720	50
25	4	Part.	ESP	3	2.0×10^5	1.0×10^3	2300	50
26	4	Part.	Scrubber	10	4.0×10^3	2.2×10^3	200	70
27	4	SO_2	SCOT**	2	1.1×10^4	2.6×10^3	7000	644
28	5	Part.	ESP	7	5.2×10^5	5.9×10^3	3600	243
29	5	Part.	ESP	16	2.0×10^5	7.9×10^2	500	260
30	6	Part.	Scrubber	3	3.0×10^4	5.0×10^2	75	50
31	6	Part.	Fabric filter	5	2.0×10^4	4.0×10^2	42	--
32	7	Part.	Mist eliminator	7	7.8×10^4	6.5×10^2	NA	NA
33	8	Part.	Fabric filter	5	1.1×10^4	1.2×10^4	600	NA
34	8	Part.	Fabric filter	3	2.1×10^6	2.2×10^4	15000	1860
35	11	HC	HC incinerator	2	2.5×10^4	8.6×10^3	2500	567
36	13	Part.	Fabric filter	6	3.2×10^5	3.2×10^3	750	250

(continued)

TABLE 1-3. (continued)

Source number	Industry* type	Principal pollutant	Control technique	Age yrs	Gas flow rate acfm	Uncontrolled emissions ton/year	Capital cost $(000)	Annual maintenance cost $(000)
37	13	Part.	Fabric filter	3	2.3×10^5	--	1400	200
38	14	Part.	Scrubber	4	1.5×10^5	5.2×10^3	NA	NA
39	14	Part.	Scrubber	8	6.5×10^4	5.0×10^2	80	27
40	16	Part.	Scrubber	10	9.0×10^3	4.0×10^2	5	NA

* Refer to Table 1-1

** Shell Claus off-gas treater.

NA - Not available.

to require auxiliary fuel in a waste gas incinerator, thus requiring an operating expense to burn it. One of these was included in this study.

1.3 Special Issues

Several delays were encountered in beginning the source visits in the Houston study. First, a Houston Chamber of Commerce official wanted to introduce the study to the companies in an open meeting. However, representatives from only three companies on the candidate source list attended the meeting. After aiding the project earlier by selecting area companies with potential sources for PEDCo's review, the Houston city agency personnel declined to introduce the project, or PEDCo, to companies directly. The project had to be introduced to the companies by letter from PEDCo. This lack of active support for the project by the city agency may have contributed to a low level of cooperation on many of the source visits.

Delays were incurred in waiting for approval from their corporate headquarters before the local plant could participate in the study. Many large industrial companies in Houston are branch plants of large corporations with headquarters outside Texas. Also, corporate approval was required before data could be transmitted to PEDCo in several instances. This caused further delays. In many cases a time lapse of 30 days or more was encountered between initial source contact and final receipt of data.

The sources selected in this study are a small percentage of the sources in the Houston-Harris County area. However, these sources represent some of the largest industries in the area and in general represent a fair cross-section of industry, both large and small, in the area.

2. ANALYSES OF STATIONARY SOURCE PERFORMANCE

The principal findings of our source inspections and evaluations are presented in this section. The findings are analyzed with respect to control equipment performance relative to compliance requirements, and with respect to the effectiveness of source/agency interaction.

2.1 Source/Agency Cooperation

We were very pleased with the cooperation of the TACB staff in Austin, the TACB Regional office in Houston, and the Air Pollution Control Section of the Houston City Health Department. The cooperation of the companies in this study was mixed; many of the source personnel complained that they had participated in many studies and surveys similar to this one, and that they had very little time for another study. Most of the sources agreed to participate on the condition that their involvement would not take much of their time. We encouraged participation by explaining to each source that (1) we needed a wide variety of sources as to industry type and size to make the conclusions more valid, (2) the identity of the source would not be revealed in the report, (3) none of the information turned over to the study would be revealed to the local agencies except as a part of the final public report, and (4) anyone requesting it would be sent a copy of PEDCo's report concerning their plant. It is our opinion that the majority of the sources that participated did so because they felt they would be making a contribution to the study. Seven sources declined to participate.

2.2 Data Quality

Good data were found principally at only the larger sources. There was a general lack of stack tests at nearly all sources. Compliance tests are usually performed within a few months after the equipment is put into operation; further tests are generally not performed unless there is reason to believe that the source is out of compliance. Compliance tests are always performed by agency personnel, either by the city agency in Houston or by the TACB stack testing team outside the city limits.

Performance tests can be conducted by source personnel or by outside contractors. These tests are conducted (1) to determine the performance level of the control equipment, (2) to use in emission inventory forms, or (3) to demonstrate performance of the equipment after modifications are made.

Continuous opacity monitors are required by TACB Regulation I if the stack flow rate is 100,000 acfm or larger and the opacity is likely to exceed 15 percent for a period of five minutes or more. Seven of the sources in this study had continuous opacity monitors. Five of these were operating on electrostatic precipitator stacks. Because of their inherent high efficiency stack tests are seldom run on fabric filters.

Some sources had no test data at all while others had only one stack test performed several years ago when the equipment was new. The TACB emission inventory files were reviewed for all the study sources. Data were found for the majority of the sources for the years 1973 and 1975. (The TACB did not require a report for the years 1974, 1976, or 1977. Another will be required for 1978.)

Production data and published emission factors were used to construct the emission profile for one source (No. 34). At another source the amount of dust being collected and the expected efficiency of the control equipment were used to estimate the emission profile (No. 36). At three sources no data were available at the source or in the TACB files.

2.3 Summary of Control Equipment Performance Analyses

The performance of the control devices was evaluated based on the available data, the results of our inspections, and the information found in the TACB files on the frequency of emissions above the regulation limit. Short-term excess emissions were used to calculate excess emissions along with any identifiable long term excess emissions. There were only a few cases of long-term emissions above the regulation limits, since all of the sources in this study are under regular surveillance by the city, county, and state control agencies. Short-term emissions are usually observed also by one or more of the agencies. The results of the emissions estimates for each source are compiled in Table 2-1. The values for uncontrolled emissions and allowable emissions were calculated by multiplying the annual emissions in tons by the age of the last installed control device as of year-end 1977. The emissions credits and excess emissions were calculated over the same period. The age of the control equipment in the table is the age at the end of 1977.

The excess emissions were calculated from the frequency of excess emission excursions and durations as obtained from the sources and information from the agency files. From these data a percentage of the time that the source was out of compliance was estimated. This time percentage was multiplied by an average emission excess to obtain the total emission excess.

The emission credits were calculated by subtracting the average annual emission from the allowable emission and multiplying by the time to get emission credits. No consideration was given here to the level at which the source should be controlled

TABLE 2-1. CONTROL EQUIPMENT PERFORMANCE

Control equipment			Emissions (Annual average x age), tons				
Source number	Type	Age	Uncontrolled emissions	Percent reduction	Allowable emissions	Emission credits	Excess emissions
21	ESP	4	67,200	96	2772	2052	0
22	Scrubber	3	2,100	-	-	-	-
23	Cyclone	1	1,728	87	216	0	252
24	ESP	8	10,368	55	4631	2298	417
25	ESP	3	2,484	56	1090	972	0
26	Scrubber	8	17,280	66	5806	466	300
27	SCOT*	2	3,960	80	792	418	86
28	ESP	7	41,580	89	4684	2420	658
29	ESP	8	6,336	40	3801	1612	752
30	Scrubber	3	1,500	-	-	-	-
31	Fabric filter	5	2,000	-	-	-	-
32	Mist eliminator	3	2,268	65	786	600	8
33	Fabric filter	4	49,920	98	811	225	125
34	Fabric filter	2	43,200	92	3447	2524	60
35	HC incinerator	1	8,640	75	2160	2800	36
36	Fabric filter	6	16,200	83	2700	2100	132
37	Fabric filters	3	-	-	-	-	-
38	Scrubber	3	17,640	90	1693	1292	100
39	Scrubber	7	3,628	58	1512	720	50
40	Scrubber	8	1,600	96	56	0	400

*Shell Claus off-gas treater.

to achieve compliance with the allowable limit continuously. It is difficult to set a level below the allowable at which all sources should be controlled because of the variation in types of sources. For example, a large source that is very constant and not subject to process upsets could be controlled only a moderate amount below the allowable limit. Whereas a source that has frequent process upsets should be controlled to well below the limit to allow for some increases in emissions to the control equipment. When a company controls the emission to a low level below the allowable limit it is responding well to agency control. An outstanding example of this is Source No. 25.

It is evident from the table that there are many more emission credits than excess emissions. There are 14 sources with emission credits higher than excess emissions and 11 sources with 10 times more emission credits than excesses. There are two sources without any excess emissions since the last installed equipment went into operation.

Table 2-2 gives the characteristics of the excess emissions by type of control device. In the table the estimated number of excess emission events is the total number in each category for all of the control devices of that type and covering the combined years. The excess emission in tons per year is the total amount divided by the combined years. This number is compared to the average allowable for all the sources controlled by this type of equipment.

The data in the table did not show any type of control device to be clearly superior to the others. Within each group there was a large variation. Within the ESP group there were two that were 10 years of age or older and two that were less than five years old. Two of the new ones had no excess emissions (see Table 2-1), while the two old ones had large excesses. Of the three larger groups of devices, as a group the scrubbers had the lowest excess emissions per year with the fabric filters slightly higher and the ESP's much higher. The other three types were one device each and no conclusions could be drawn from these. In the case of the cyclone a major design deficiency caused the majority of the excess emissions.

Table 2-3 gives the characteristics and amounts of the excess emissions by industry type. The number of excess events is the total for that industry covering the combined years. The greatest number of excess events was in the refinery, grain handling, and cement industries, although the data were not available to make an estimate as to the number of events in the cement industry. The largest amount was in the cement industry with the petroleum industry being the next highest. The smallest amount was zero for the two recovery boilers at a pulp mill and another zero for an ESP at an FCCU at a refinery.

TABLE 2-2. EXCESS EMISSIONS FOR CATEGORIES OF CONTROL DEVICES STUDIED IN HOUSTON, TEXAS

Control device type	Combined years	Estimated number and duration of excess emission events				Estimated excess emissions ton/yr	Percent allowable	Emission indicators
		1-12 mos	1-4 wks	1-7 dys	1-24 hrs[a]			
ESP (5)	30	1	8	76	1750	48	8.5	1,3,4,5
Fabric filters (3)	12	0	4	13	262	23	6	1,3,4,5
Scrubbers (4)	21	0	3	7	813	20	4	1,3,4,5
Claus off-gas treater (1)	2	0	3	0	0	43	10	1,3,4,5
Hydrocarbon incinerator (1)	1	0	0	0	14	36	2	3,4,5
Cyclone[b] (1)	1	1	0	0	0	252	116	1,4,5

Sources 22, 30, 31, 37, and 40 were not used because of incomplete data.

[a] The number of excursions above allowable emission rates for 1 hour or less cannot be estimated in most cases.

[b] This poor performance is due to inadequate process design.

Emission indicators:
1. Opacity records.
2. Malfunction reports.
3. Operating logs.
4. Stack tests.
5. Engineering judgment.

TABLE 2-3. EXCESS EMISSIONS FOR CATEGORIES OF SOURCES STUDIED IN HOUSTON, TEXAS

Source	Combined years	Estimated number and duration of excess emission events				Estimated excess emissions ton/yr	Percent allowable	Emission indicators
		1-12 mos	1-4 wks	1-7 dys	1-24 hrs[a]			
Pulp mill Recovery boilers	4	0	0	0	0	0	0	1,2,4,5
Thermal oxidation	3	0	1	2	36	-[b]	-[b]	1,2,4,5
Refineries (4)	20	2	9	20	800	48.5	32.5	1,3,4,5
Refineries (1) Off-gas treater	2	0	3	0	0	43	10	1,3,4,5
Cement plants (2)	15	-[b]	-[b]	-[b]	-[b]	94	17	1,4,5
Asphalt plants (2)	8	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]	
Mineral acid (1)	3	0	0	3	33	2.7	1	1,4,5
Iron and steel (2)	6	0	4	12	154	26	2	1,3,4,5
Petrochemical (1)	1	0	0	0	14	36	2	3,4,5
Grain handling (1)	6	0	0	12	972	22	5	1,3,5
Fertilizer (2)	10	0	0	10	380	15	5	1,3,4,5
Surface coating (1)	8	8	0	0	0	50	400	

[a] The number of excursions above allowable emission rates for 1 hour or less cannot be estimated in most cases.

[b] Data not available.

Emission indicators:
1. Opacity records.
2. Malfunction reports.
3. Operating logs.
4. Stack tests.
5. Engineering judgment.

TABLE 2-4. CAUSES OF EXCESS EMISSIONS

Causes	Primary cause no. of sources	Contributing cause no. of sources
Poor design efficiency	6	7
Improper maintenance	2	5
Lack of spare parts	0	4
Routine component failure (not preventable)	3	7
Improper materials of construction	0	2
Improper operation	0	4
Process upsets	5	3
Lack of instrumentation	0	1

TABLE 2-5. MEANS OF CORRECTING THE SOURCES OF EXCESS EMISSIONS

Strategy	Could make major reduction in excess emissions no. of sources	Would make smaller reduction in excess emissions no. of sources
Improve permit review for new source	1	0
Require more complete spare parts inventory	3	4
Increase maintenance requirements	2	12
Require annual stack tests	0	4
Retrofit of additional control equipment	3	2

significantly in the past five to eight years. The agencies use all of the means at their disposal to achieve stationary source emission reductions when needed.

General Finding No. 1 - Court action is an effective means of obtaining compliance with regulations.

Sometimes court action is slow because of the court process itself, but a definite plan is worked out, and schedules are set that ultimately work out to a definite conclusion by a specific date. In seven of the sources studied in this report (Sources 21, 22, 25, 32, 33, 34, 38) the county and the TACB brought court actions to force the sources to install suitable equipment by a specified date with good results. The city agency along with the TACB filed court suits on one source (Source 23) within the city limits.

General Finding No. 2 - Constant surveillance is an effective means of obtaining constant source awareness of excess emissions.

The sources in the Houston area are under almost constant surveillance by all three regulatory agencies. The sources are aware that when excess emissions occur the agencies are very likely to observe it. In this case the sources are more likely to maintain constant vigilance on their effluents since they know that excess emissions are likely to attract attention.

General Finding No. 3 - TACB Regulation VI is an effective means of controlling emissions from new stationary sources.

For all new stationary sources constructed after 1973 the TACB regulation VI requires that an application must be submitted to the TACB for review and approval before construction begins. The regulation requires that the sources utilize BACT equipment and the opacity limit is 20 percent for all visible emissions. The new construction permit was required for Sources 21, 23, 25, 27, and 30. In the case of Source 23 the permit review team did not require the use of BACT equipment. This was an apparent failure of the review system to function properly.

For existing sources, BACT equipment is not required, and the opacity limit is 30 percent; thus relatively high emissions are legally permitted.

General Finding No. 4 - The TACB general reporting Rules 7 and 8 are frequently used and abused by the sources.

TACB General Rule 7 requires that a source notify the city, county, and state agencies whenever they encounter an upset condition that is likely to cause excess emissions to occur. A resulting excessive emission above regulation limits is then not considered by the agencies to be a regulation violation if the source is deemed to be exercising reasonable diligence in bringing the emission under control. At times this provision seems to be overexercised by the sources. The rule seems to be utilized in some cases as a substitute for the installation of proper control equipment.

General Finding No. 5 - Spare equipment and parts inventories are inadequate in most cases.

Spare parts inventories at most sources in this study are at the minimum required level or less, and spare equipment is almost non-existent. For processes that must operate continuously all equipment should be spared and the critical items should be installed in stand-by status for immediate use when needed. Source 34 has some critical equipment, such as a reverse air blower, in stand-by status. In our opinion spare parts inventories at most sources should be doubled and some spare pieces of equipment purchased to increase the on-line operating time of the air pollution control equipment.

General Finding No. 6 - O & M programs are generally at a low level.

Personnel at the majority of the sources studied were reluctant to discuss O & M procedures and preventive maintenance programs. Their general comments were that the air pollution control equipment received the same O & M activity as the process equipment. None of the sources described a comprehensive preventive maintenance program. The best programs described were at the sources that shut down the process at intervals for a thorough cleaning and repairing of the air control equipment (Sources 21, 22, 25, 27, 34. 39).

Additional instrumentation would be helpful as well, such as vibration monitors for fan housings and manometers mounted on fabric filters and scrubbers.

General Finding No. 7 - Current emissions are difficult to quantify; emissions tests are generally not performed on a regular basis.

In many cases sources have been stack tested only once to determine compliance, and little data exist to confirm continuing compliance. For particulate sources, the agencies use only opacity observations as an indicator of noncompliance after the initial tests. Obviously, this method cannot be used for SO_2

or hydrocarbons. A better system incorporating more continuous monitoring and/or regular stack tests to verify continuing compliance with regulations is needed.

APPENDIX A

SOURCE DESCRIPTIONS

SOURCE 21
ELECTROSTATIC PRECIPITATORS ON TWO RECOVERY BOILERS AT A PULP MILL

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Pulp mill
Number of Employees	1500

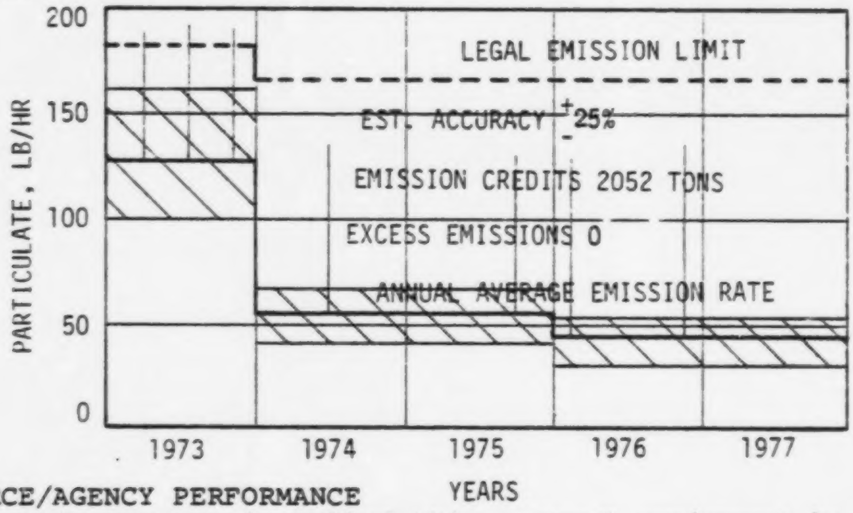
B. Pollutant Characteristics

Type of Control Device	Particulate
Uncontrolled Emission Rate	4000 lb/hr
Controlled Emission Rate	46 lb/hr
Applicable Regulation Limit	165 lb/hr 20% opacity

C. Control Device Characteristics

Type of Control Device	ESP (2)
Capacity of Control Devices	500,000 acfm total
Age of Control Equipment	5 years
Capital Cost	$3.6 million
Annual O & M	$0.93 million

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This company installed this control equipment in 1973 and 1974 to satisfy requirements of a law suit. The suit was brought against the company in March 1973 by the county agency and the TACB after investigating numerous odor complaints in 1970 through 1973. This equipment eliminated the "snowing" problem and reduced overall particulate emissions. The source has been in continuing compliance since that time according to the TACB annual inspection reports. Short opacity excursions occur a few times per year. Major repairs are made twice per year during shutdowns.

SOURCE 22
CAUSTIC SCRUBBER ON A THERMAL OXIDATION UNIT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Paper pulp mill
Number of Employees	1500

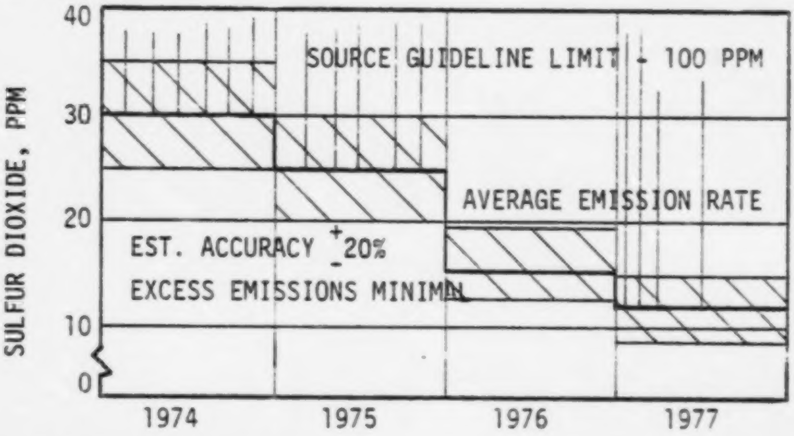
B. Pollutant Characteristics

Type of Pollutant	Sulfur dioxide
Uncontrolled Emission Rate	10,000 ppm
Controlled Emission Rate	15 ppm
Applicable Regulation	TACB Rule 5 - TRS odor

C. Control Device Characteristics

Type of Control Device	Caustic Scrubber
Capacity of Control Device	5000 scfm
Age of Control Equipment	4 years
Capital Cost	Not available
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This company constructed a thermal oxidation unit in 1974 in response to a court order by Harris County and the TACB in 1972. This court order was initiated after many odor complaints had been investigated and numerous N.O.V.'s had been issued. The unit destroys odorous sulfur compounds formed in the Kraft pulp process. In burning these compounds, SO$_2$ is formed which must be removed from the gases by a caustic scrubber. Several odor complaints have been investigated since that time. Odors were usually due to process upsets. TACB annual inspection report indicated that the unit is in compliance with regulations except during these occasional upset conditions.

SOURCE 23
MULTIPLE CYCLONES ON A FLUID CATALYTIC CRACKING UNIT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Oil Refinery
Number of Employees	500

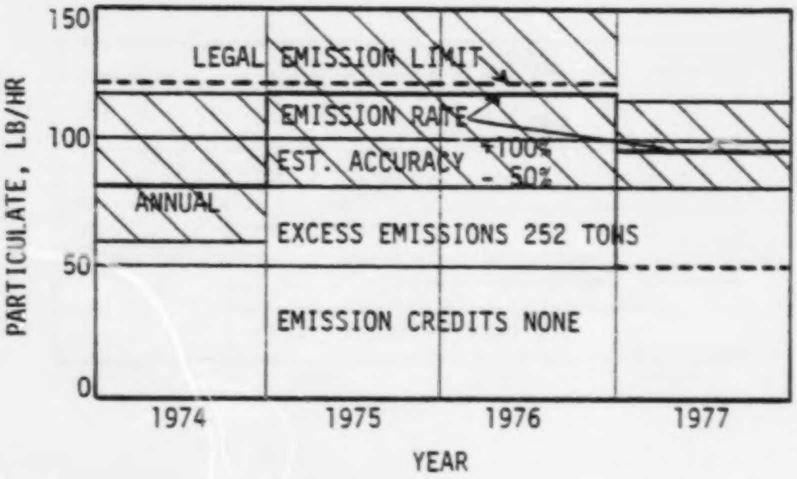
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	400 lb/hr
Controlled Emission Rate	95 lb/hr
Applicable Regulations	50 lb/hr 20% opacity

C. Control Device Characteristics

Type of Control Device	Cyclones
Capacity of Control Device	100,000 scfm
Age of Control Equipment	2 years
Capital Cost	$200,000 (Est.)
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The company constructed this control equipment in 1976 to comply with a 1975 court order. The control equipment was constructed under the TACB New Construction Permit Regulation, but was not required to utilize Best Available Control Technology (BACT). Results of compliance tests by TACB in 1977 showed that the source was out of compliance. Excess opacity violations have also been recorded by the city. There is no indication what legal action the city or the TACB will take in this matter.

SOURCE 24
ELECTROSTATIC PRECIPITATOR ON A CATALYST RECOVERY UNIT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Oil Refinery
Number of Employees	1500

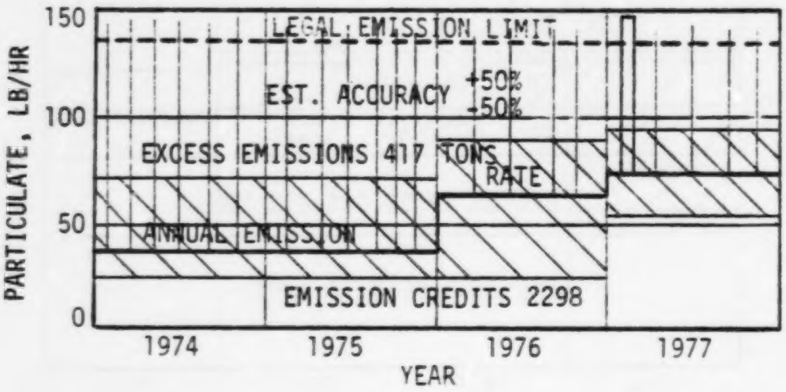
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	300 lb/hr
Controlled Emission Rate	76 lb/hr
Applicable Regulation	134 lb/hr

C. Control Device Characteristics

Type of Control Device	ESP
Capacity of Control Device	410,000 acfm
Age of Control Equipment	8 years
Capital Cost	$720,000 (1970)
Annual O & M Cost	$50,000 (1973)

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This equipment was installed in 1970 to comply with new regulations being adopted by the TACB. The unit has allowed the source to operate generally within regulation limits since that time. The ESP has lost some efficiency in the past two years which has resulted in higher emissions. Opacity violations occur during process upsets. No O & M data were obtained.

SOURCE 25
ELECTROSTATIC PRECIPITATOR ON A CATALYST RECOVERY UNIT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Oil Refinery
Number of Employees	450

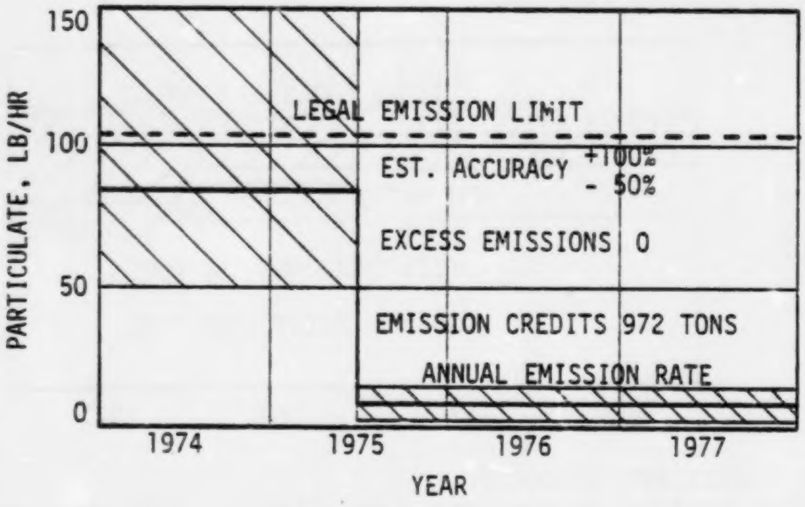
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	230 lb/hr
Controlled Emission Rate	8 lb/hr
Applicable Regulation	101 lb/hr 30% opacity

C. Control Device Characteristics

Type of Control Device	ESP
Capacity of Control Device	290,000 acfm
Age of Control Device	3 years
Capital Cost	$2.3 million (1975)
Annual O & M Cost	$50,000

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This company installed an ESP on an existing FCCU to control particulate emissions fulfilling the requirements of a 1974 court order. The source was subject to numerous violations in the early 1970's. The ESP has successfully controlled particulate emissions and has enabled the company to operate almost continuously within regulation limits. O & M procedures appear to be quite adequate.

SOURCE 26

SCRUBBER ON FCC CATALYST RECOVERY SYSTEM

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Oil Refinery
Number of Employees	3,750

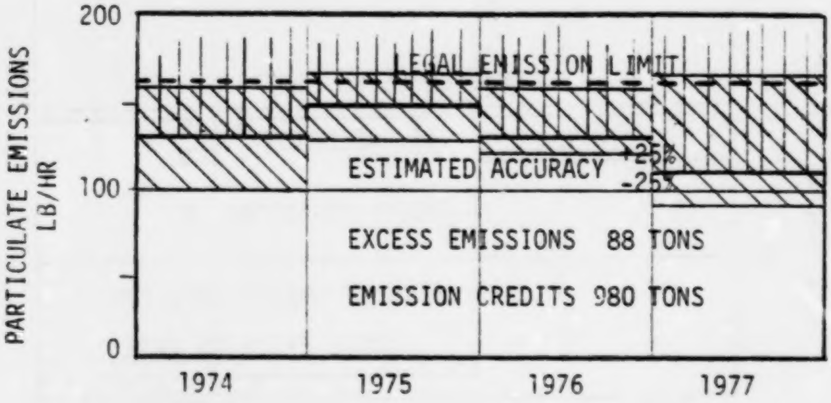
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	500 lb/hr
Controlled Emission Rate	139 lb/hr
Applicable Regulation	168 lb/hr limit 30% opacity

C. Control Device Characteristics

Type of Control Device	Spray scrubber
Capacity of Control Device	4000 scfm
Age of Control Equipment	15 years
Capital Cost	$250,000 (1963)
Annual O & M Cost	$70,000

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This control system was installed in 1963 for product recovery purposes and was upgraded in 1972 to meet particulate and opacity regulations. Excess emissions usually result from process upsets. The source is regarded by the TACB to be marginally in compliance. This system requires major repairs every six years whereas minor repairs are made as needed. O & M procedures were not described by the company.

SOURCE 27
OFF-GAS TREATMENT FACILITY ON A CLAUS SULFUR RECOVERY UNIT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Oil Refinery
Number of Employees	3750

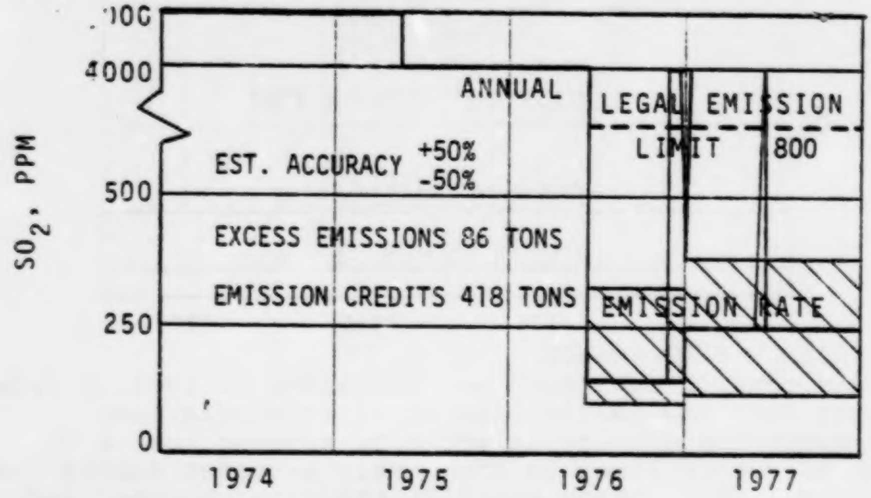
B. Pollutant Characteristics

Type of Pollutant	Sulfur dioxide
Uncontrolled Emission	5000 ppm
Controlled Emission Rate	250 ppm
Applicable Regulation	800 ppm limit

C. Control Device Characteristics

Type of Control Device	Claus off-gas treater
Capacity of Control Device	10,500 acfm
Age of Control Equipment	2 years
Capital Cost	$7 million (1978)
Annual O & M Cost	$644,000 (1977)

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The company installed a Shell Claus Off-gas Treater (SCOT) unit in 1976 on a new Claus sulfur recovery unit on a TACB permit. SO_2 emissions were reduced to an average of 250 ppm compared to a permit limit of 800 ppm. The SCOT unit has operated within the permit limit except for three shutdown periods in 2 years. Two of these were due to equipment failures and one due to a process upset in the Claus unit. O & M procedures are the same as for refinery process equipment, according to the company engineer.

SOURCE 28
ELECTROSTATIC PRECIPITATORS ON CEMENT KILNS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Portland Cement
Number of Employees	190

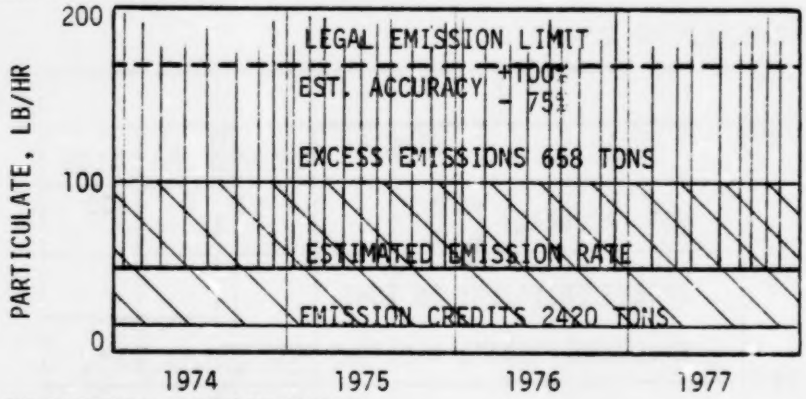
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	1500 lb/hr (est.)
Controlled Emission Rate	50 lb/hr (est.)
Applicable Regulation	169 lb/hr 30% opacity

C. Control Device Characteristics

Type of Control Device	ESP's
Capacity of Control Device	525,000 acfm
Age of Control Equipment	7 and 21 years
Capital Cost	$3,645,000 (1971)
Annual O & M Cost	$243,000

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This control equipment was installed in 1971 in order to comply with new particulate emission regulations. Normal operating opacity is about 10 percent, but a 30 percent allowable limit is frequently exceeded during upset conditions. The company notifies the city, county, and state agencies of upset conditions approximately 200 times per year. In spite of this, the city routinely issues 6 to 10 N.O.V.'s per year. Although no formal abatement action has been taken, it is apparent that the company is making a sham of a technical loophole and that better control equipment should be installed to comply with the intent of existing opacity regulations. Little O & M data were provided, except that the unit is throughly reworked once per year during a process shutdown.

SOURCE 29
ELECTROSTATIC PRECIPITATOR ON A CEMENT KILN

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Cement plant
Number of Employees	90

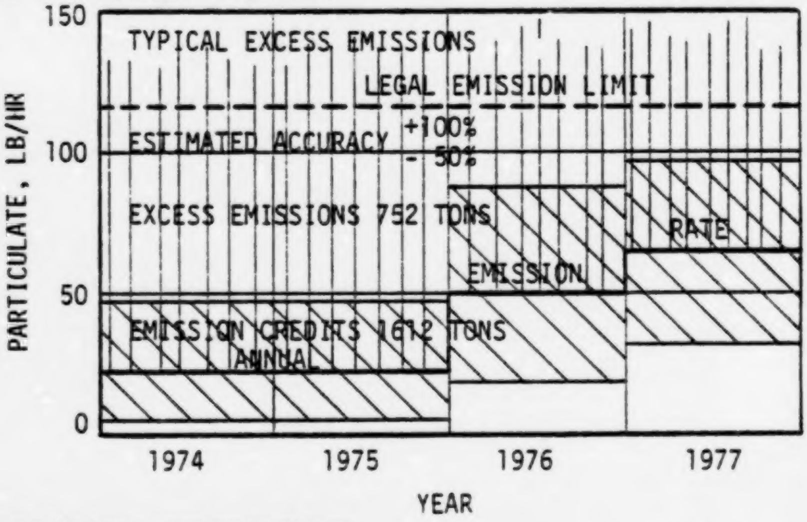
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	200 lb/hr (est.)
Controlled Emission Rate	65 lb/hr
Applicable Regulation	120 lb/hr 30% opacity

C. Control Device Characteristics

Type of Control Device	ESP
Capactiy of Control Device	200,000 acfm
Age of Control Equipment	16 years
Capital Cost	$500,000 (1962)
Annual O & M Cost	$260,000

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The company installed an ESP on this cement kiln when it was built in 1962. The ESP is 16 years old and the source has difficulty keeping it in full operation. In addition the cement manufacturing process has frequent upsets. Many Rule 7 and 8 notifications are in the file (130 in 1978). More than 10 N.O.V.'s were issued to the source by the city agency in 1977. At present there are no court suits or legal action pending against this plant. O & M procedures were not given but costs were said to be high.

SOURCE 30
VENTURI SCRUBBER ON AN ASPHALT DRIER-MIXER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Hot Mix Asphalt
Number of Employees	70

B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	500 ton/yr (est.)
Controlled Emission Rate	0.0305 gr/dscf
Applicable Regulation	0.04 gr/dscf

C. Control Device Characteristics

Type of Control Device	Venturi scrubber
Capacity of Control Device	30,000 dscfm
Age of Control Equipment	3 years
Capital Cost	$75,000 (1975)
Annual O & M Cost	$50,000 (est.)

II. ANNUAL EMISSIONS PROFILE

Insufficient data to construct a profile.

III. SOURCE/AGENCY INTERACTION

This plant was constructed in 1975 on a Construction Permit under TACB Regulation VI making this a new source. Although the city agency has issued six N.O.V.'s to the company through 1977, this is a good performance since the source has a 20 percent opacity permit limit. One notice required that the parking lot be paved. It appears that this company has performed better than most of its competitors. O & M procedures were not given in detail.

SOURCE 31
FABRIC FILTER ON A GRAVEL DRYING KILN

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Hot Mix Asphalt
Number of Employees	7

B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	400 ton/yr (est.)
Controlled Emission Rate	Not known
Applicable Regulation	30% opacity

C. Control Device Characteristics

Type of Control Device	Fabric filter
Capacity of Control Device	20,000 acfm (est.)
Age of Control Equipment	5 years
Capital Cost	$42,000 (1973)
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE

Unknown - No tests

III. SOURCE/AGENCY PERFORMANCE

This company moved to a location near a residential area in 1974. This generated frequent citizen complaints from nearby areas. The city obtained a court injunction in 1975 ordering the company to eliminate excess emissions. Plant sources stated that most complaints are caused by emissions from other parts of the plant and that the fabric filter is relatively trouble-free. It appears that the odor producing part of this plant has no control equipment on it.

SOURCE 32
MIST ELIMINATOR ON A SULFURIC ACID PLANT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Fertilizer
Number of Employees	481

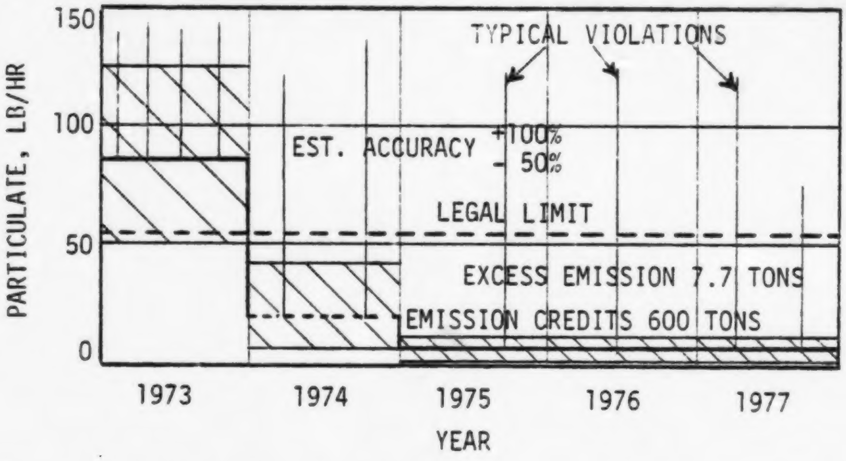
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	150 lb/hr
Controlled Emission Rate	5 lb/hr
Applicable Regulation	52 lb/hr

C. Control Device Characteristics

Type of Control Device	Mist Eliminator
Capacity of Control Device	78,000 acfm
Age of Control Equipment	7 years
Capital Cost	Not available
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The city agency and the TACB issued numerous N.O.V.'s to this sulfuric acid plant for excess opacity and particulate emissions in the years 1970 to 1973. The source installed an ammonia spray scrubber in July 1971, but it was not effective in reducing particulate emissions. The TACB initiated court action in February 1973 and obtained a court order in June 1973 directing the elimination of excess sulfuric acid plant emissions by December 31, 1973. A mist eliminator, installed November 1973, has allowed the acid plant to operate well within regulatory limits since that time except for occasional process upsets. O & M procedures were not available.

SOURCE 33
FABRIC FILTER ON SINTER PLANT BREAKER END

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Steel mill
Number of Employees	4500

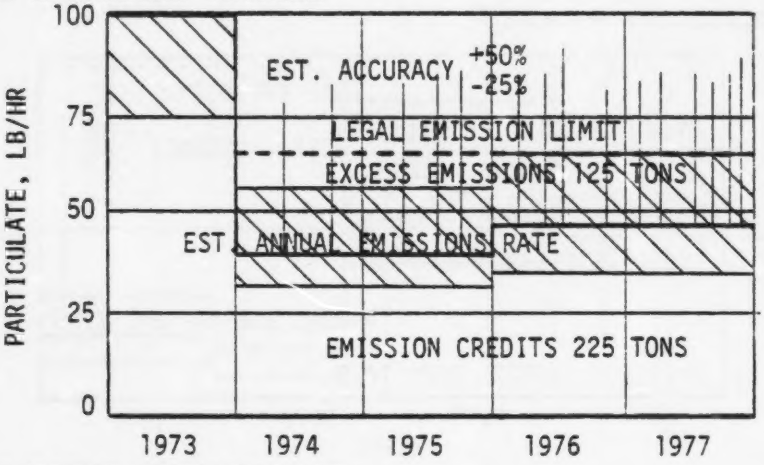
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	4000 lb/hr
Controlled Emission Rate	40 lb/hr
Applicable Regulation	65 lb/hr limit 30% Opacity

C. Control Device Characteristics

Type of Control Device	Fabric filter
Capacity of Control Device	112,000 acfm
Age of Control Equipment	5 years
Capital Cost	$600,000 (1973)
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The company installed a fabric filter in January 1974 to comply with a court suit that was filed by Harris county and the TACB initially in 1970 and finalized in May 1973. Numerous N.O.V.'s were issued to the company previously by all three regulatory agencies. This fabric filter controlled particulates well within regulations for a year or more before unexpected maintenance problems caused particulate emissions to exceed regulations during equipment failures. The company is experimenting with methods to bring the filter back into efficient operation. The TACB is aware of the problem . Maintenance has been increased as required.

SOURCE 34
FABRIC FILTER ON AN ELECTRIC FURNACE SHOP

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Steel Mill
Number of Employees	4500

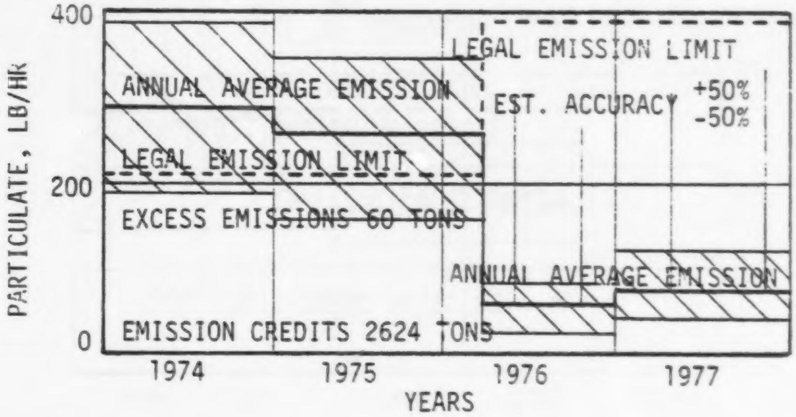
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	5000 lb/hr.
Controlled Emission Rate	81 lb/hr.
Applicable Regulation	399 lb/hr. 30% opacity

C. Control Device Characteristics

Type of Control Device	Fabric filter
Capacity of Control Device	1.7 Million scfm
Age of Control Equipment	3 years
Capital Cost	$15 Million
Annual O & M Cost	$1.86 Million

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

Heavy fugitive emissions from the electric furnace shop in the late 1960's and 1970 violated TACB regulations, and the three air pollution control agencies issued citations to the source. The county agency and the TACB entered a law suit against the company in 1970 to abate emissions. A final settlement in May 1973, directed the company to eliminate fugitive emissions from the furnace shop by December 31, 1975. The company began operating a fabric filter in March 1976. Significant system failures were indicated in 1976 and 1977. O & M procedures were not detailed by the company.

SOURCE 35
WASTE GAS INCINERATOR AT A CHEMICAL MANUFACTURING PLANT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Chemical
Number of Employees	496

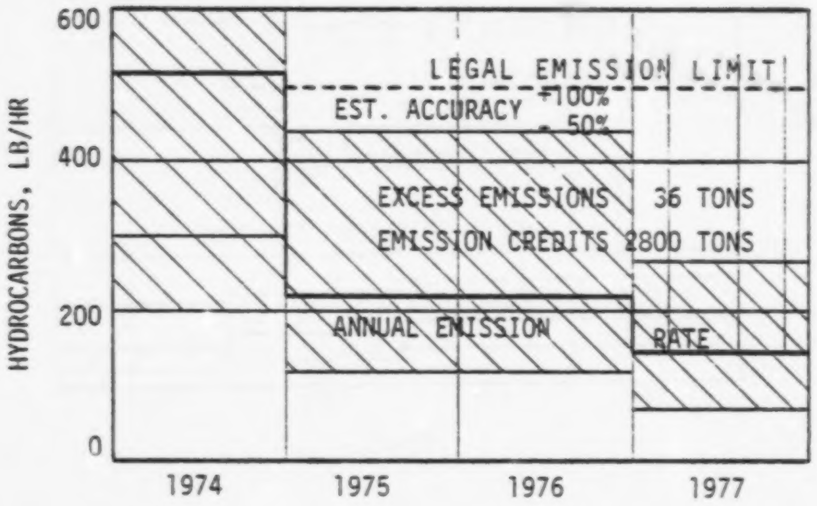
B. Pollutant Characteristics

Type of Pollutant	Hydrocarbons
Uncontrolled Emission Rate	2000 lb/hr
Controlled Emission Rate	150 lb/hr
Applicable Regulation	500 lb/hr

C. Control Device Characteristics

Type of Control Device	Waste gas incinerator
Capacity of Control Device	235,000 lb/hr gas
Age of Control Equipment	2 years
Capital Cost	$2.5 million
Annual O & M Cost	$567,000

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This incinerator was installed in 1977 in response to tighter hydrocarbon regulations and a desire by the company to eliminate excess odor emissions. Although in general compliance with regulations previously, the company had received odor complaints. The plant has been able to operate almost continuously within regulation limits with the incinerator in operation. O & M procedures appear to be adequate.

SOURCE 36
REVERSE AIR JET FABRIC FILTERS AT GRAIN HANDLING FACILITY

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Grain Storage
Number of Employees	78

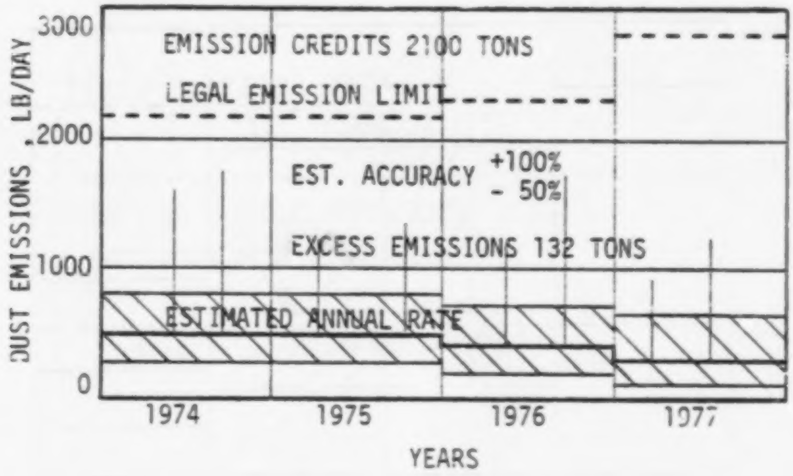
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	18,000 lb/day
Controlled Emission Rate	300 lb/day
Applicable Regulation	3000 lb/day

C. Control Device Characteristics

Type of Control Device	Fabric Filters
Capacity of Control Device	325,000 acfm total
Age of Control Equipment	one to eight years
Capital Cost	$750,000 accum. total
Annual O & M Cost	$250,000 (est.)

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This company installed 10 fabric filters in 1970 to control excess grain dust emissions at the request of the TACB Region 7 inspectors. These brought the source into compliance for several years. Eight additional fabric filters were installed in 1975, through 1977 at the request of TACB personnel. O & M procedures appear to be very good. No visible emissions were observed during our visit.

SOURCE 37

FABRIC FILTER ON GRAIN HANDLING OPERATIONS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Grain Storage
Number of Employees	55

B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	Not known
Controlled Emission Rate	No tests
Applicable Regulation	Agricultural Exemption TACB Rule 5

C. Control Device Characteristics

Type of Control Device	Fabric filters
Capacity of Control Device	227,000 acfm total
Age of Control Equipment	three to eight years
Capital Cost	$1.4 million since 1971
Annual O & M Cost	$200,000 (est.)

II. ANNUAL EMISSIONS PROFILE

Unknown - No tests

III. SOURCE/AGENCY PERFORMANCE

This company has been in general compliance with regulations since 1976 when it completed a program to replace cyclones with fabric filters controlling dust from grain handling operations, according to the TACB annual inspection reports. The TACB inspectors have issued several N.O.V.'s to this company even though it operates under an agricultural exemption rule which exempts companies engaged in processing agricultural products from the provisions of TACB Regulation I. TACB Rule 5 governs excess visible emissions and odors from any source. O & M procedures appear to be adequate to keep the filters in good operating condition.

SOURCE 38
VENTURI SCRUBBERS ON AN AMMONIUM PHOSPHATE MANUFACTURING PLANT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Fertilizer
Number of Employees	481

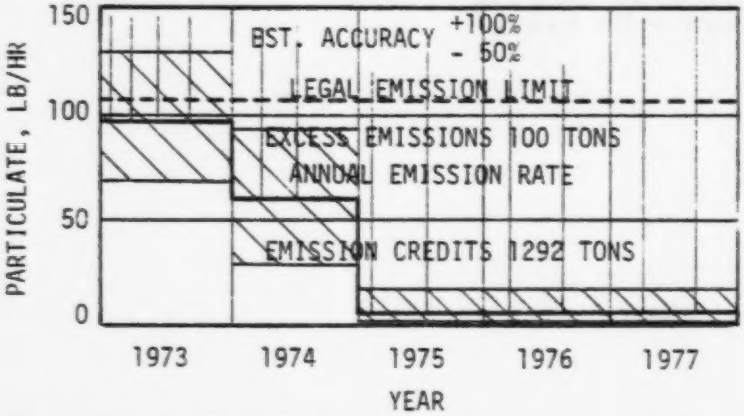
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	1200 lb/hr (est.)
Controlled Emission Rate	5 lb/hr
Applicable Regulation	112 lb/hr 30% opacity

C. Control Device Characteristics

Type of Control Device	Venturi Scrubbers
Capacity of Control Device	149,000 acfm total
Age of Control Equipment	4 and 11 years
Capital cost	Not available
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

Three scrubbers and ten cyclones, installed in 1967, proved to be inadequate to control fertilizer dust emissions effectively in the early 1970's. Particulate emission violations were recorded by the three agencies and numerous N.O.V.'s were issued to the company. Three venturi scrubbers were installed in 1974 in response to a court order in 1973, obtained by the TACB, directing the company to eliminate excess particulate emissions. These scrubbers, in series with the original scrubbers, have allowed the plant to operate generally below regulation limits except for process upsets. O & M procedures were not available.

SOURCE 38
VENTURI SCRUBBERS ON AN AMMONIUM PHOSPHATE MANUFACTURING PLANT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Fertilizer
Number of Employees	481

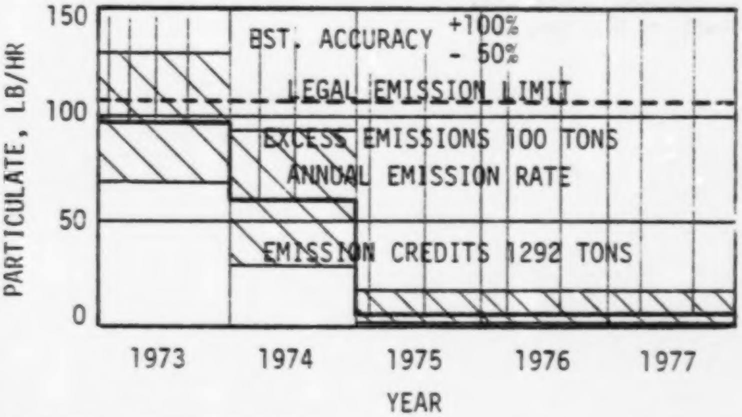
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	1200 lb/hr (est.)
Controlled Emission Rate	5 lb/hr
Applicable Regulation	112 lb/hr 30% opacity

C. Control Device Characteristics

Type of Control Device	Venturi Scrubbers
Capacity of Control Device	149,000 acfm total
Age of Control Equipment	4 and 11 years
Capital cost	Not available
Annual O & M Cost	Not available

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

Three scrubbers and ten cyclones, installed in 1967, proved to be inadequate to control fertilizer dust emissions effectively in the early 1970's. Particulate emission violations were recorded by the three agencies and numerous N.O.V.'s were issued to the company. Three venturi scrubbers were installed in 1974 in response to a court order in 1973, obtained by the TACB, directing the company to eliminate excess particulate emissions. These scrubbers, in series with the original scrubbers, have allowed the plant to operate generally below regulation limits except for process upsets. O & M procedures were not available.

SOURCE 39
SPRAY SCRUBBERS ON AMMONIUM PHOSPHATE DRYER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Fertilizer
Number of Employees	140

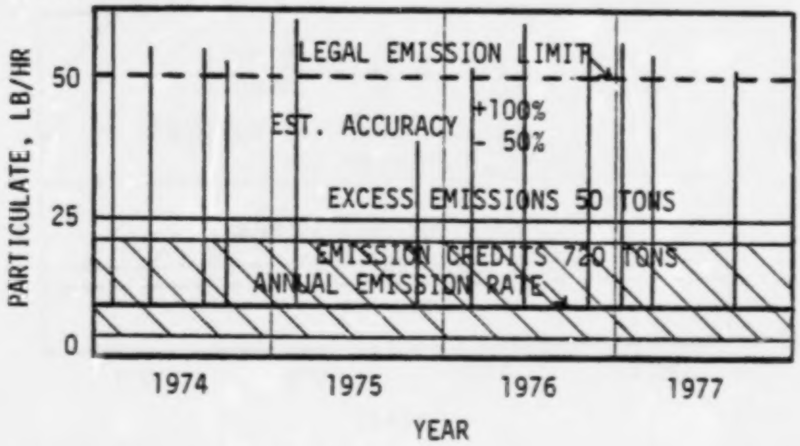
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	120 lb/hr
Controlled Emission Rate	10 lb/hr
Applicable Regulation	50 lb/hr 30% opacity

C. Control Device Characteristics

Type of Control Device	Spray Scrubbers
Capacity of Control Device	65,000 acfm
Age of Control Equipment	8 and 12 years
Capital Cost	$80,000 (1970)
Annual O & M Cost	$27,600

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This source has generally maintained complaince with emission regulations since the installation of a scrubber in 1970. Typically the city issues the source one to three N.O.V.'s annually. Excess opacity excursions due to process upsets are not regarded by the city as violations when the company reports those upsets. The scrubber is marginal or inadequate for continued compliance at current high plant throughput rates. A routine maintenance program insures that the scrubber nozzles are inspected daily. Plugged nozzles are replaced while the scrubbers are on-line, and the unit is shut down each week for thorough cleaning.

SOURCE 40
WATER SCRUBBER ON PIPE COATING OPERATION

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Plant	Pipe Coating Facility
Number of Employees	25

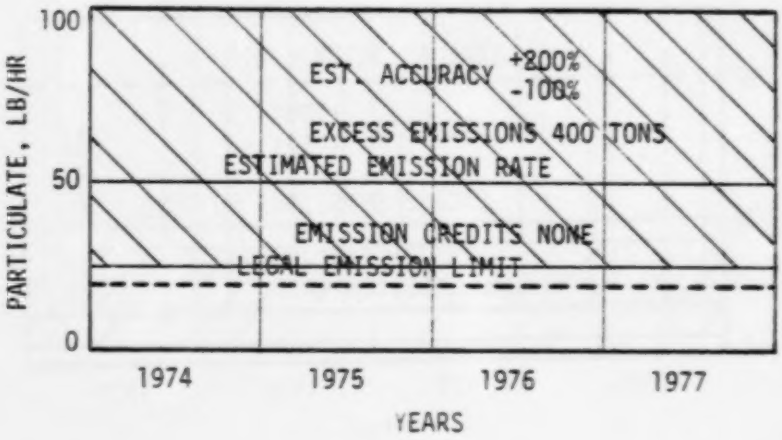
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	400 lb/hr (estimate)
Controlled Emission Rate	56 lb/hr (estimate)
Applicable Regulation	14 lb/hr

C. Control Device Characteristics

Type of Control Device	Water scrubber
Capacity of Control Device	9000 cfm
Age of Control Equipment	10 years
Capital Cost	$5000 (1968)
Annual O & M Cost	no data

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

Scrubber emissions are about four times the current regulatory limit, and fugitive emissions are ten times the limit. The existing hood captures only about 80 percent of the emissions. A new facility, with a fully enclosed hood, is being built to replace this plant. The agency has not indicated an awareness of the existing noncompliance problem. O & M procedures are minimal. Repairs are made as required.

APPENDIX B

SOURCE INSPECTION REPORTS

INSPECTION REPORT

Source 21

1.0 Summary of Visit

These pulp mill electrostatic precipitators (ESP's) are used to control particulate emissions from recovery boilers No. 6 and No. 7. Total particulate and total reduced sulfur (TRS) emissions are individually regulated by TACB. SO_2 emissions from boiler No. 7 are also regulated. TACB records indicate that the entire pulp mill has been in compliance with applicable regulations since 1973. Annual TACB source inspections are conducted. The company appears to make conscientious efforts tc minimize periods of noncompliance and to take positive steps to prevent violations. Opacity and SO_2 profiles are given for the source. Opacity excursions occur for a few minutes at a time a few times per year, but these are not regulation violations unless the opacity limit is exceeded for longer than five minutes in any 60-minute period. A continuous SO_2 monitor on boiler No. 7 showed a few excursions above the limit for a few hours at a time. No violations for particulate emissions have been noted by the agency.

2.0 Chronology of Source/Agency Interaction

1970-1972	Many odor complaints were investigated and Rule 5 violations were noted by the three agencies.
1972	TACB adopted more stringent regulations.
1972-July	A construction permit was granted for No. 7 recovery boiler.
1973-March	A court order required elimination of excess emissions by December 1973.
1973-December	No. 7 recovery boiler became operational.
1974-1976	Very few instances of excess particulates or opacity were noted by the agencies.

1977 TACB annual inspection report stated that no N.O.V.'s were issued for particulate emissions or opacity, but that the source had some problems with excess odors.

2.1 Compliance History

Prior to the effective dates of the TACB applicable regulations (1956-1966) the company operated two recovery boilers, Nos. 5 and 6. Particulate emissions were 30-40 lb/hr from No. 5 and 50-70 lb/hr from No. 6. ESP units installed on those boilers were current technology at that time.

Both ESP units began to deteriorate between 1960 and 1969. At the same time the TACB promulgated particulate emissions limitations for 1972. The No. 5 ESP was upgraded with the addition of a third chamber and both units were in compliance with the TACB particulate emission regulations which were to become effective in 1972. The upgrading program also eliminated "fallout" as a nuisance.

In 1972 the Harris County Pollution Control Department filed an odor nuisance suit against the mill. The suit required that the company upgrade ESP's and that both recovery boilers operate at less than 4 ppm TRS emissions. Additionally, the suit required the collection and incineration of certain TRS emissions.

In 1972 and 1973 the No. 6 ESP was upgraded to increase its efficiency from 96 percent to 99.8 percent. The No. 7 recovery unit was installed and made operational in 1973. With the installation of No. 7 and modifications to No. 6, the TRS and particulate requirements were met.

Annual inspections are conducted by the TACB regional office. Since 1973 each report has shown the mill to be in compliance with all applicable rules and regulations. The TACB once pointed out a need to control dust from roadways, and the mill complied with that request. During periods of major upset conditions every effort is made to minimize the noncompliance period and to bring the unit within allowable levels as soon as possible. Each noncompliance event is reviewed by the company to find the cause, so that steps can be taken to prevent future violations.

3.0 Plant and Process Description

The No. 6 and No. 7 ESP's are part of a large pulp and paper mill with a capacity of 800 ton/day of air-dried pulp. The recovery boilers are an important part of the pulp mill, recovering large quantities of chemicals for reuse in the digesters, and generating steam for use in other parts of the mill. The Kraft pulp process used at this mill consists of digesting wood chips in an aqueous solution of three parts sodium hydroxide to one part of sodium sulfide. The mixture is put in a digester and cooked at an elevated pressure (100 to 135 psig) and temperature, (340° F) two to five hours. The actual sulfidity and the cooking time are both variable depending on product requirements. After cooking, the mixture is discharged to the blow tank, then to the filter, where the pulp is separated from the spent cooking liquor (black liquor). The separated pulp is then processed through intermittent stages of washing and bleaching, and later pressed and dried to be sold as pulp or made into paper products.

Inorganic chemicals in the black liquor must be recovered to maintain satisfactory economics. Organic contaminants which must be removed include reduced sulfur compounds and mercaptans. The first step in the recovery process is oxidation of the sodium sulfide to a thiosulfate form which reduces H_2S emission in the recovery unit's direct contact evaporator. The oxidized liquor is concentrated to about 50 percent solids in a multiple-effect evaporator, and is further concentrated to about 70 percent solids in a direct contact evaporator, heated by recovery boiler flue gases. This 70 percent concentrate is sprayed into the recovery boiler where sodium carbonate and sodium sulfide are formed. These chemicals are recovered from the floor of the furnace. They are then redissolved in water in the smelt tank producing "green liquor". Calcium hydroxide (slaked lime) is added to this liquor converting (causticizing) the sodium carbonate to sodium hydroxide and producing "white liquor" which is reused in the digester. The calcium carbonate produced in the causticizing process is filtered and fed to a kiln where it is converted to calcium oxide, then slaked to calcium hydroxide for use in the causticizing process.

The flue gases from the recovery boiler contain particulates, SO_2, and some reduced sulfur compounds. These gases pass through the ESP where particulates are removed and opacity is reduced to less than 10 percent. The black liquor oxidation process keeps the TRS compounds to a minimum.

4.0 Air Pollution Control Equipment

Each recovery boiler is equipped with an ESP. Pertiment data are given in Table 21-1:

Table 21-1: ESP Data

	No. 6 ESP	No. 7 ESP
Date installed	1958	Dec. 1973
Major modification	1972,73	
Manufacturer	Koppers	Koppers
Pollutant controlled	Particulates	Particulates
Gas flow (acfm)	280,000	220,000
Number of chambers	3	2
Number of electrical fields	6	8
Design efficiency, %	99.8	99.8
Actual efficiency (1977), %	99.5	99.7
Design inlet conc. (gr/dscf)	5.0	8.0
Guaranteed outlet conc. (gr/dscf)	0.01	0.014

(Units do not quite meet guarantee.)

5.0 Performance Evaluation

Although these ESP's do not meet the manufacturer's performance guarantee, they do meet regulatory requirements continuously with only a few exceptions. More problems have been encountered with No. 6 than No. 7, probably because it is an earlier model that was rebuilt.

5.1 Maintenance and Repairs

Each ESP is designed such that the total load can be bypassed to one chamber (two chambers on No. 6) and meet applicable opacity and particulate emission limits while maintenance is being performed on the other chamber. Inspections of critical items is on a daily basis. Major repairs are made twice per year when the recovery boilers are shut down for inspection and repairs. During this period each ESP is thoroughly examined and repaired.

The flexibility of the ESP units plus twice-a-year thorough inspections has proven to be an effective maintenance program. Both ESP units are essentially 100 percent reliable. Overall, the ESP's have a better reliability than the process equipment.

Operator training is a must, according to the company spokesman. The company places the same priority on operator training for pollution control equipment as for process equipment. Daily observation and monitoring of critical operating parameters is necessary in order to insure reliable operation. Operators receive classroom training in addition to on-the-job training supervised by experienced operators.

Major repairs to the No. 6 and No. 7 ESP's are listed below:

No. 6 ESP

Year	Repair Description	Cost
1975	Replace inlet and outlet dampers	$ 65,000
1975	Replace center wire and plate	5,500
1975	Insulation repairs	11,400
1975	Replace electrical field	148,200
1975	Replace TRS-SO_2 monitor system	29,000
1975	Replace expansion joint	9,900
1975	Replace ductwork	12,000
1978	Replace TRS-SO_2 monitor system	46,000
1978	Addition of TR sets and rapper controls	161,000
	Total	$488,000

No. 7 ESP

Year	Repair Description	Cost
1974	Modify wet bottom	$ 13,600
1975	Overlay wet bottom	16,400
	Total	$ 30,000

5.2 Emissions Data

The compliance tests were conducted by the TACB stack testing team in March through August 1974. The results are given in Table 21-2.

Table 21-2: TACB Compliance Test Results

Pollutant	No. 6 Boiler (lb/hr)	No. 7 Boiler (lb/hr)
ESP Stack		
Particulates (9-test avg.)	23.3	18
Particulates (9-test range)	13-35	8-31
Particulates regulation	95[a]	70[b]
TRS (avg.)	1.2	c
TRS regulation	2	2[b]
Opacity (avg.), %	10-15	1
Opacity regulation, %	30[a]	20[b]

Dissolving tank stack		
Particulates (avg.)	d	8
Particulates regulation	-	10[b]
H_2S (avg.)	d	0.1
H_2S regulation	-	1[b]
Opacity (avg.) %	d	10
Opacity regulation, %	30[a]	20[b]

Key to Table
a - TACB Regulation I
b - TACB Permit No. C-70
c - not detected
d - not tested

Table 21-3: 1977 Company Test Results

Pollutant	No. 6 Boiler	No. 7 Boiler	No. 7 Smelt Tank
Particulates (lb/hr)	20	8	8
TRS (lb/hr)	1.2	0.8	0.3
Opacity (%)	8-10	1-3	10-12

Table 21-4: Chronological Summary of Emissions (lb/hr)

	No. 6 and No. 7 Boilers		Total Mill
Period	Particulate	TRS	TRS
1965-1973	130	12	40
1974-1975	57	1.5	5-7
1976-1977	46	2	5-7

Chronological particulate data are plotted in Figure 21-1.

Continuous Monitors

Continuous opacity and SO_2 monitors are installed in the No. 7 ESP stack. The daily chart records for both of these monitors were reviewed for the years 1976 and 1977. Weekly averages and all instances of regulation violation were recorded. These data are plotted in Figures 21-2 and 21-3. The SO_2 monitor was installed in June 1976. The legal emission limit for SO_2 is shown as 265 ppm, whereas the actual limit is 250 lb/hr. At maximum gas flow and 265 ppm SO_2 the 250 lb/hr limit is just reached, but at a lower gas flow higher SO_2 concentration may be within limits. The company uses 265 ppm as a flag point to indicate a possible violation.

A typical 24-hour opacity profile for boiler No. 7 is shown in Figure 21-4. Two plots are shown; one to show that there is very little variation over a 24-hour period, and one to show the calibration sequence of one spike per hour. A typical daily SO_2 profile is shown in Figure 21-5 showing the zero and calibration sequences; there is little variation over a 24-hour period.

6.0 Cost Data

6.1 Capital cost:

No. 6 ESP	$1,479,500
No. 7 ESP	2,090,000
Total	$3,569,500

6.2 Operating and Maintenance Costs (1977)

Cost Unit	ESP cost for No. 6 & No. 7	Total Recovery process (incl. ESP)
Labor, Benefits	$214,100	$1,538,200
Parts & materials	93,900	469,400
Contractual repairs	15,000	202,800
Utilities	302,000	1,597,600
General expenses	1,000	219,300
Fixed charges, (taxes, depr., & ins.)	307,100	1,096,300
Total	$933,100	$5,123,600

Total pulp mill O & M; $22,665,000

Recovery ESP O & M was 18.2 percent of total recovery process O & M.

Recovery ESP O & M was 4.1 percent of total pulp mill O & M.

Table 21-5 gives a summary of capital expenditures for the years 1970 through 1977. Table 21.6 gives a summary of operating and maintenance expenditures, 1970-

1977. Table 21-7 gives a comparison of air abatement O & M and total O & M.

6.3 Spare parts cost:

Precipitators	\$64,800
Opacity instruments	\$10,300
TRS & SO_2 monitor	\$ 4,000
Total	\$79,100

Table 21-5: CAPITAL EXPENDITURE SUMMARY

Year	Total Mill Capital $\$ \times 10^6$	Total Mill Environmental Capital $\$ \times 10^6$	Ratio of Environmental Capital to Total Capital	Total Air Abatement Capital $\$ \times 10^6$	Ratio - Air Abatement to Total Capital	Ratio Air Abatement to Total Environmental
1970	5.499	4.483	0.81	0.499	0.09	0.11
1971	2.058	1.399	0.68	0.153	0.07	0.11
1972	10.491	6.374	0.61	6.069	0.58	0.95
1973	7.864	5.794	0.74	5.608	0.71	0.97
1974	6.984	3.187	0.46	2.485	0.36	0.78
1975	5.380	4.141	0.77	0.548	0.10	0.13
1976	6.679	2.647	0.39	0.003	neg.	neg.
1977	9.809	1.419	0.14	0.134	0.014	0.09
Total	54.764	29.444	0.54	15.499	0.28	0.53

Table 21-6: Operating and Maintenance Expenditures Summary

Year	Total Mill O & M $\$ \times 10^6$	Pulp Mill O & M* $\$ \times 10^6$
1970	36.439	9.795
1971	37.208	9.694
1972	41.158	11.264
1973	45.158	12.665
1974	53.623	16.312
1975	55.161	17.912
1976	63.871	19.528
1977	73.983	22.665

*All air pollution control equipment for this facility is contained within the pulp mill operations. Pulp mill operating cost is given to provide perspective for Table 21-7 which follows.

Table 21-7: Air Pollution Control O & M Versus Total O & M (1977)

Mill O & M	
Total Mill O & M	$73,983 x 10^6
Pulp Mill O & M	$22,665 x 10^6
Air Pollution Control O & M	
ESP's	$ 933,100
Black Liquor Oxidation (BLO)	$ 246,300
Thermal Oxidation Facility	$ 501,500
Other Sources Not Surveyed	$ 499,000
Total Air Pollution Control O & M	$2,179,900

Ratio of Total Air Pollution Control O & M to Pulp Mill O & M = 9.6%

Ratio of Total Air Pollution Control O & M to Total Mill O & M = 2.9%

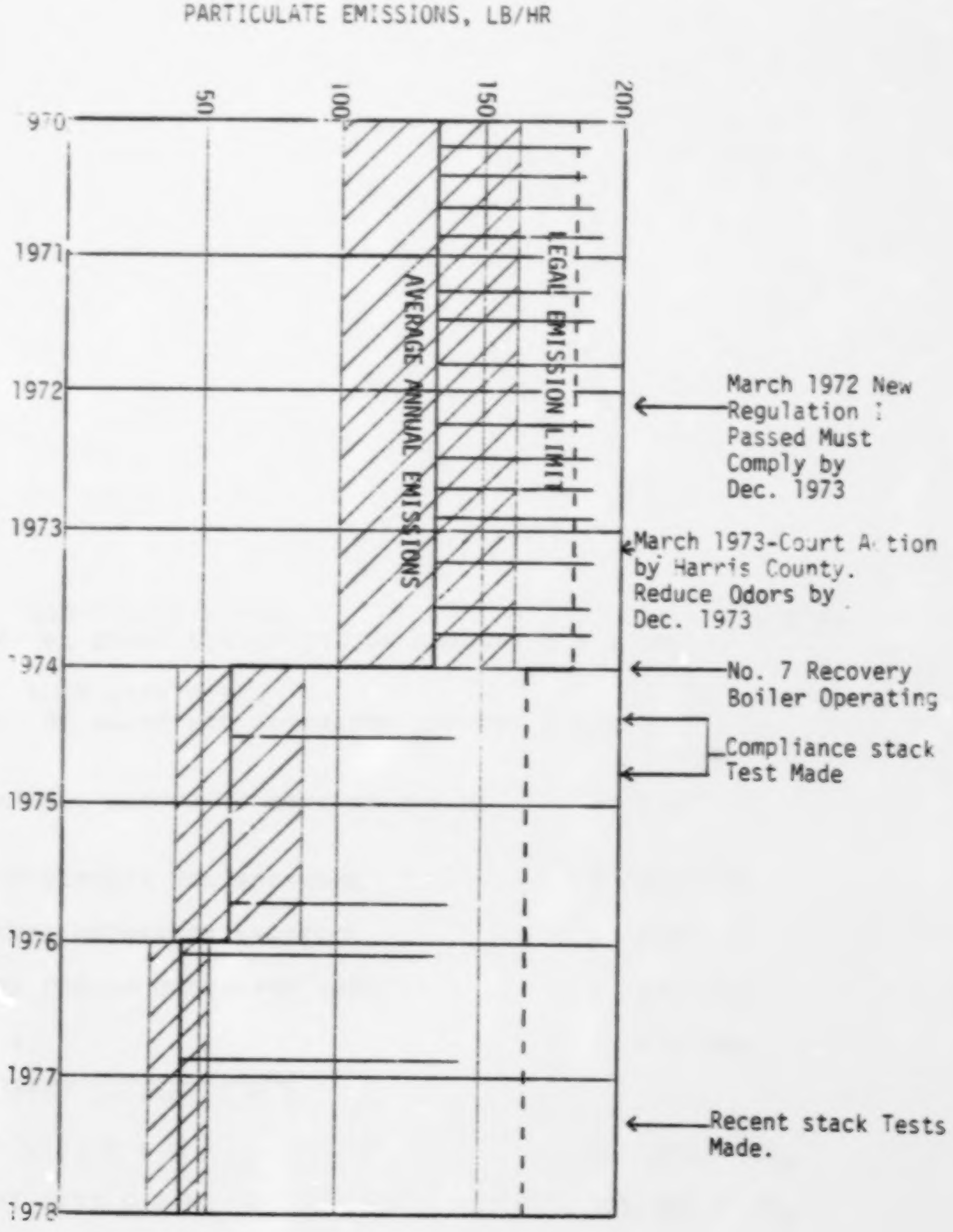
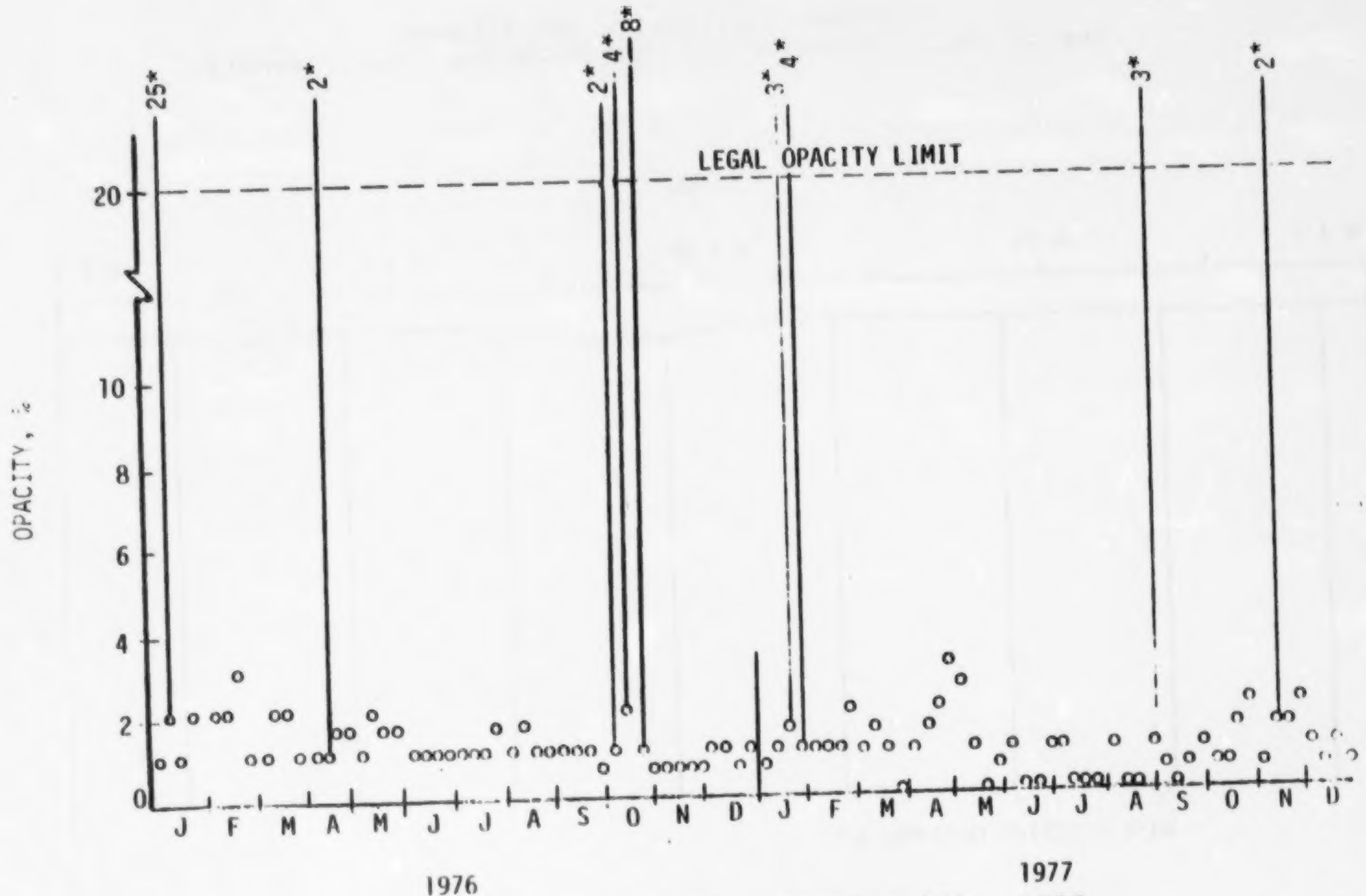


Figure 21-1. Electrostatic precipitator - Eight year emission profile.



*MINUTES THAT OPACITY EXCEEDED 20%. LESS THAN 5 MINUTES IS NOT A REGULATION VIOLATION.

Figure 21-2. Electrostatic precipitator. Weekly average opacity in 1976 and 1977.

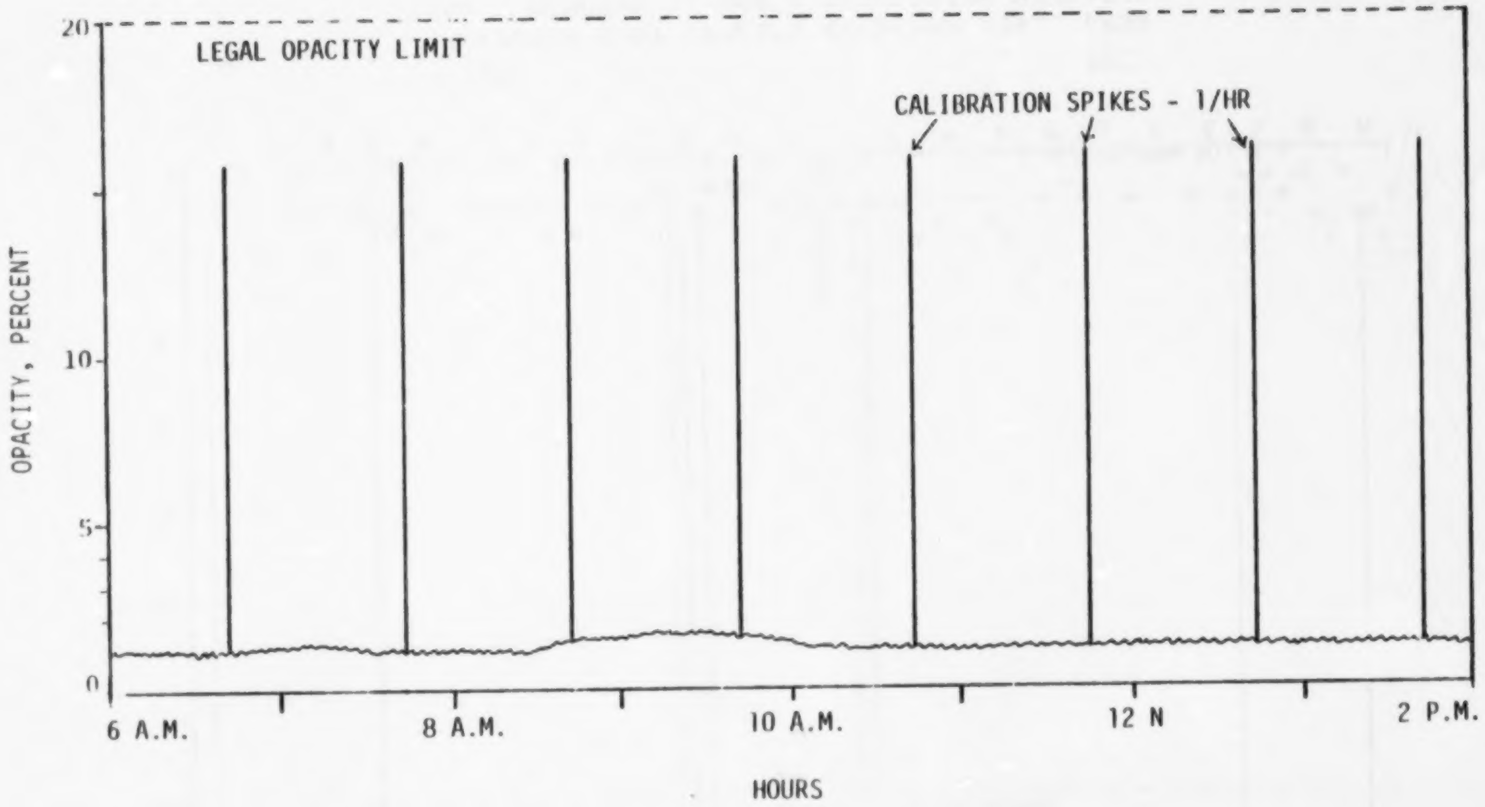


Figure 21-4b. Electrostatic precipitator - Typical day opacity and calibration sequence.

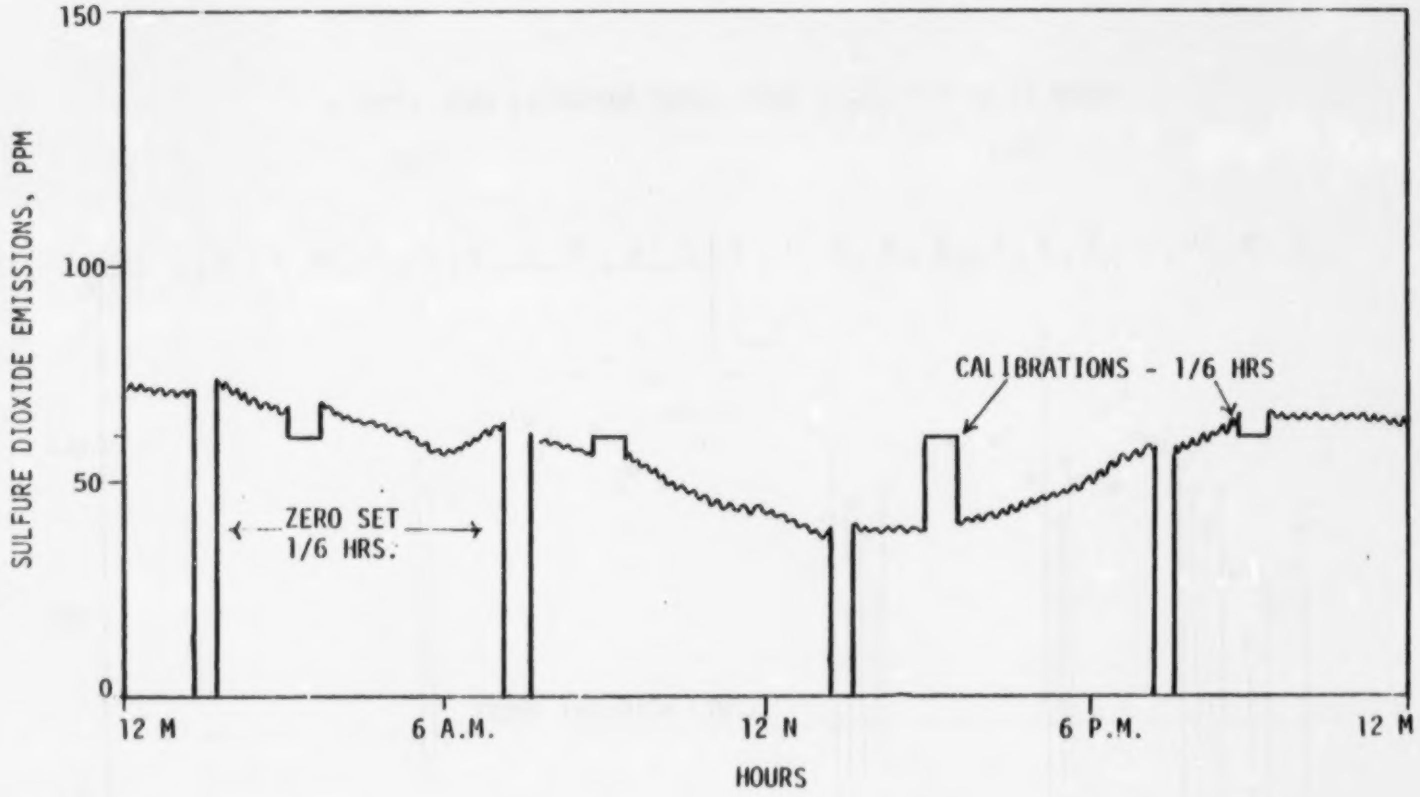
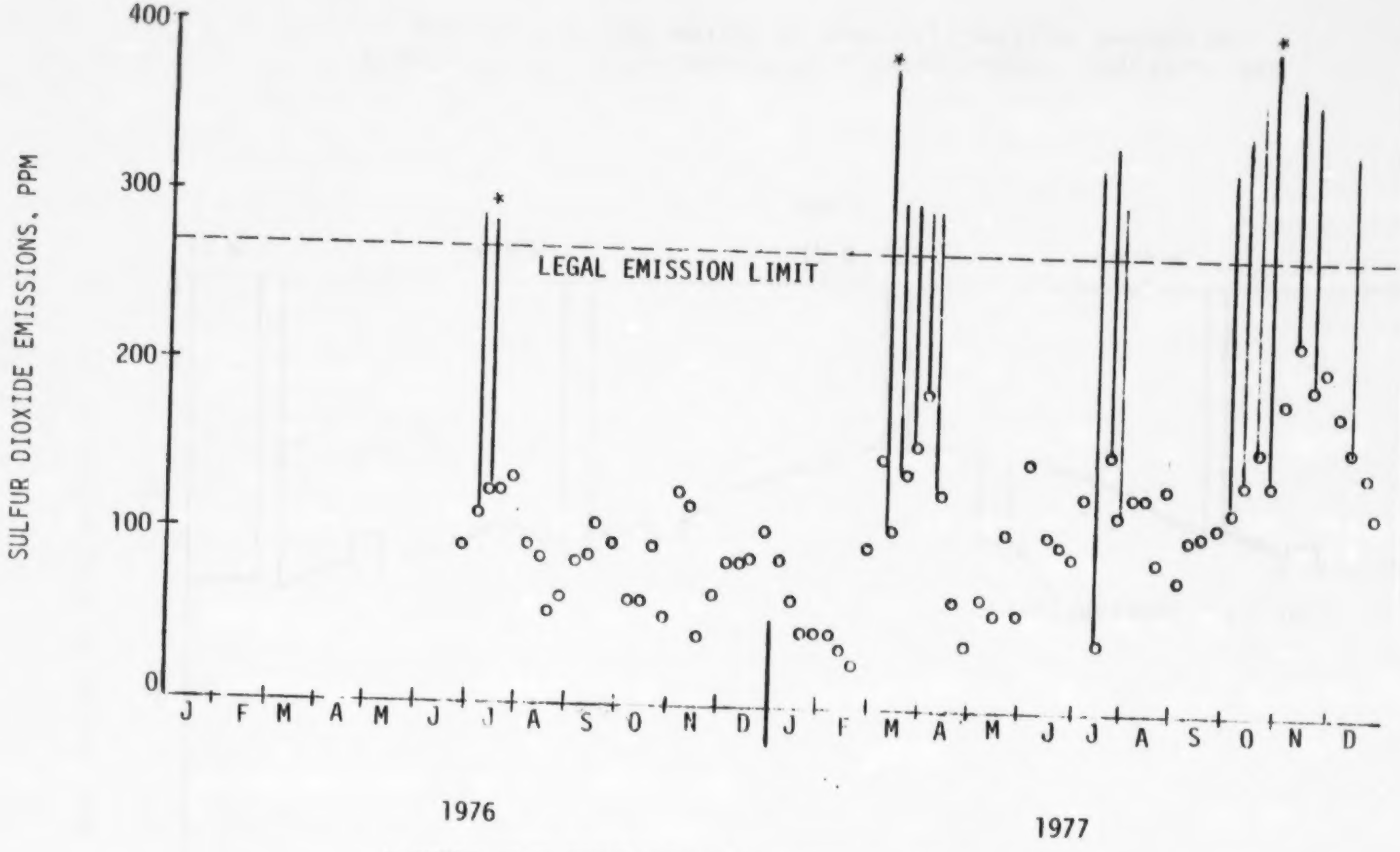


Figure 21-5. Electrostatic precipitator. Typical day sulfur dioxide emission and calibration sequence.



* SHORT TERM EXCURSION ABOVE LEGAL LIMIT - 1 TO 13 HOURS

Figure 21-3. Electrostatic precipitator - Weekly average sulfur dioxide emissions in 1976 and 1977

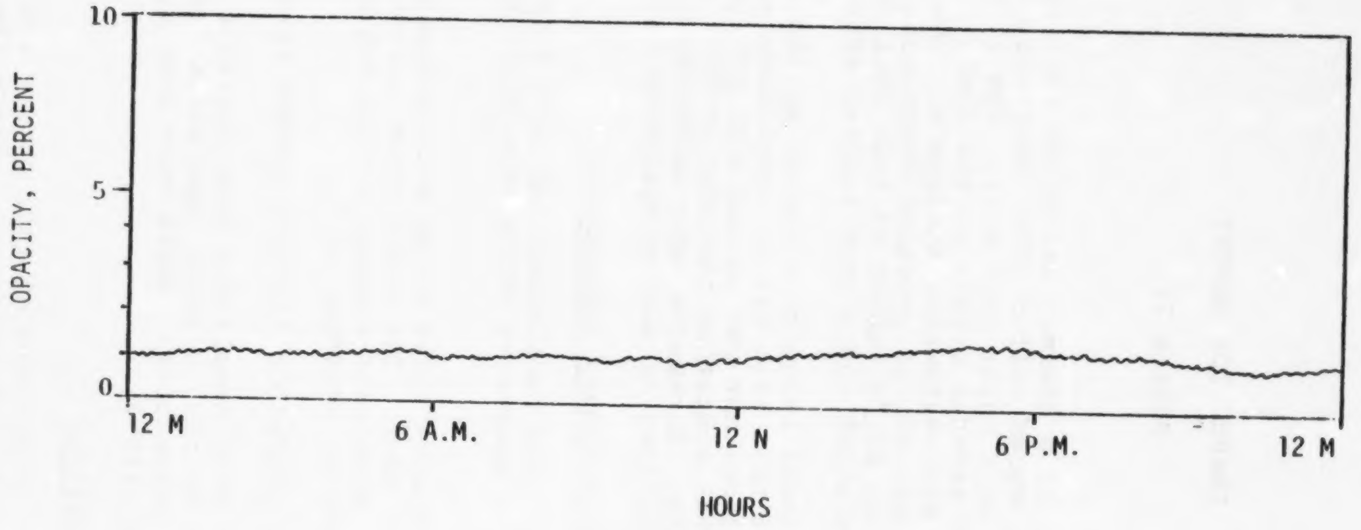


Figure 21-4a. Electrostatic precipitator - Typical day opacity

INSPECTION REPORT

Source 22

1.0 Summary of Visit

The operation of a thermal oxidation facility, (TOF) to destroy total reduced sulfur (TRS) compounds is an important process in a paper pulp mill. These TRS compounds are collected from several points in the Kraft pulp process by gas collectors and wastewater strippers. When the TRS compounds are burned, SO_2 is produced which must be removed from the gases. The SO_2 scrubber at this facility has a good record of operation and a good removal efficiency.

The latest annual inspection report by the regulatory agency stated that this mill was in compliance with all applicable regulations but was having some problems with odors. Under normal operation the odor control processes seem to be adequate. Excessive odor emissions occur during process upset conditions or during equipment malfunctions.

2.0 Chronology of Source/Agency Interaction

1970-1972	Numerous odor complaints and TACB Rule 5 violations for excessive odors were noted in TACB files.
1972	County agency filed a law suit against the company for odor. The court order directed the company to eliminate excessive odor and particulate emissions by December 1973.
1974	Thermal oxidation facility became operational.
1975-1977	Several odor complaints from citizens were investigated by city, county, and state regulatory agency inspectors. Odors were usually due to process upsets.

2.1 Compliance History

Annual inspections of this source are conducted by TACB Region 7 office personnel. Since the annual report program began in 1973, each report has stated that the mill was in compliance with all applicable rules and regulations.

Odors from TRS compounds, hydrogen sulfide and other sulfur compounds, have been a historic problem with paper pulp mills. The Harris County Air Pollution Control Department filed an odor nuisance suit against the company in 1972. The suit required the company to upgrade the recovery boilers to operate at TRS concentrations not exceeding 4 ppm, to collect and incinerate certain TRS emissions, and to collect certain contaminated process waters for stripping of TRS compounds. This led to the installation of a condensate stripper and a TOF. With the installation of this facility, subsequent performance tests showed that the company was in compliance with total TRS emissions.

The company environmental control director stated that regulatory agencies view compliance as meeting applicable limits or conditions 100 percent of the time. However, the TACB does allow noncompliance during major upset conditions; during these periods the source cannot cause a public nuisance, nor emit quantities which would cause a violation of state or federal air quality standards. Occasional violations of a maximum hourly emission limit are considered to be a noncompliance event. When such events are reviewed by the TACB, consideration is first given to the impact on public health and ambient air quality standards. Additionally, the TACB reviews the frequency of noncompliance and actions taken to correct and prevent future violations. The company spokesman stated that during periods of major upset conditions every effort is made to minimize emissions and to bring the unit within allowable levels as soon as possible. Each noncompliance event is reviewed to determine its cause and to identify steps for prevention of future violations.

The SO_2 scrubber and other parts of the system experience occasional upsets. Only a small number of complaints concerning excess odors have been brought against the company since the thermal oxidizer has been operating. Many upsets and scheduled maintenance periods have been reported to the agency. However, the company seems to have done an outstanding job in controlling odors, relative to other paper pulp mills. The 1977 annual report by TACB Region 7 office stated that no N.O.V.'s were issued in the past few years for opacity, but that the source is still having some problems with odors.

3.0 Plant and Process Description

The TOF reviewed here is a part of a large pulp and paper mill with a capacity of 800 ton/day of air dry pulp. The Kraft pulp process used at this mill consists of digesting wood chips in an aqueous solution of 3 parts sodium hydroxide to 1 part of sodium sulfide. The mixture is put in a digester and cooked at an elevated pressure (100 to 135 psig) and temperature (340° to 350° F) for 3 to 5 hours. After cooking, the mixture is discharged to the blow tank, then to the filter where the pulp is separated from the spent cooking liquor. The separated pulp is then processed through intermittent stages of washing and bleaching, and is later pressed and dried to be sold as pulp or to be made into paper products.

During the cooking period the digester gases are relieved periodically to the turpentine recovery system. The noncondensable gases from this system are metered directly into the TOF.

Figure 22-1 is a flow diagram of the Kraft pulping and recovery process. The chemical recovery process generates some additional sulfide gases and condensate water contaminated with sulfides. All of these gases and condensates are collected and treated in the TOF at this mill.

A summary of the vapor and condensate collection systems is given below.

Vapor Collection System

1. Digester blow gases are handled separately. Moisture is removed by condensation, and essentially dry noncondensable gases are collected and metered into the TOF.
2. Evaporator noncondensable gases are vented directly from the hot wells to the TOF.
3. The by-product process vent, turpentine decanter vents, and tall oil cooler vents are fed directly to the incinerator.
4. Process liquor storage tanks for white, black, and green liquors are vented to the suction side of the condensate stripper blower.

Condensate Collection System

Condensates contaminated with TRS compounds from the digester blow gas condenser, evaporator, and turpentine decanter are air-stripped; the extracted TRS compounds are incinerated.

4.0 Air Pollution Control Equipment

The TOF is a total air pollution abatement process for control of TRS emissions. The unit is designed to handle TRS emissions from various operating facilities. Daily mill production is 800 tons of bleached Kraft pulp.

The TOF includes the following major components:

a. Condensate stripper

Designer	- Chemetics International
Stripper tray manufacturer	- Koch
Number of trays	- 12
Design air flow	- 4,000 scfm
Design condensate flow	- 900 gpm
Inlet pressure	- 3 psi
Outlet pressure	- 30" H_2O
Design efficiency (TRS Compounds)	- 90%
Actual efficiency (TRS Compounds)	- 85-90%

b. Incinerator

Manufacturer	- Hirt
Number of units	- 2 (one non-operating stand-by)
Design air flow	- 5,000 scfm
Residence time	- 0.5 sec
Design efficiency	- TRS discharge not to exceed 4 ppm
Inlet concentration	- 8,000-10,000 ppm TRS as H_2S
Outlet concentration	- 8,000-10,000 ppm SO_2 2 ppm TRS as H_2S
Operating temperature	- 1,500° F

c. SO_2 scrubber

Manufacturer	- Western Precipitation
Type	- Impingement trays (5)
Pressure drop	- 8" H_2O

Scrubbing medium - Caustic (8-10 percent caustic makeup)
Inlet concentration - 8,000-10,000 ppm SO_2
Outlet concentration - 20-50 ppm SO_2

Start-up date - July 1974

Life potential - unit should operate for an additional 5-10 years without major repairs or replacements. However, routine maintenance costs will continue to increase.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

Since incineration essentially destroys all TRS compounds, the overall efficiency of this abatement process is measured by on-stream time. The mill's objective is to achieve an annual average of 97 percent. In order to accomplish this goal, the unit is shut down twice per year (three days each) for preventive maintenance. During these shutdown periods, all operational components and safety devices are throughly checked and repaired or replaced if necessary. This facility handles explosive mixtures of gases; thus many safety features are built into the process. Since a lot of the safety devices do not function during normal operations, simulation tests are conducted during the semiannual shutdowns.

Thus far, the mill has achieved an annual on-stream time of 94-96 percent.

In order to reduce the impact of TRS emissions during shutdown periods, auxiliary scrubbers are utilized on digester blow gases and evaporator noncondensable gases. For short-term downtimes (under two hours), a scrubber is installed on the emergency bypass. The emergency bypass of all gases occurs when certain operational parameters are exceeded (the main purpose of which is to prevent explosions).

The caustic scrubber operates nearly 100 percent of the time. The biggest problem with this unit is blinding of the holes in the impingement trays. Once every three weeks the scrubber must be acid cleaned for a period of one to two hours. The caustic pump and the blower are both spared with standby units ready for immediate service. Spares of all other parts of the scrubber are kept on hand.

When the scrubber is down the incinerator must be shut down and the gases are treated with auxiliary scrubbers. The regulatory agencies are notified each time this facility has a shutdown or upset condition.

5.2 Emissions Data

Performance Test Results: Conducted by the company stack testing unit.

	1974 Actual	Allowable	1978 Actual
*Particulates	3.0 lb/hr	12 lb/hr	3.1 lb/hr
Total reduced sulfur	0.5 ppm	NA	1 ppm
Sulfur dioxide	30 ppm	NA	20 ppm
Opacity	5 %	20%	5%

Summary of TRS emissions before and after 1973 APC program.

Year	Recovery Boilers TRS lb/hr	Thermal Oxid. Facility lb/hr	Total Mill TRS lb/hr
1970-73	12	NA	40
1974-Current	2	0.1	5-7

Total mill TRS data above are plotted in Figure 22-2, Emissions Profile - Thermal Oxidation Facility. A continuous SO_2 monitor was installed in April 1976 on the scrubber stack. The daily charts were reviewed and monthly averages were recorded and plotted in Figure 22-3. The 100 ppm level is not the legal limit, it is a mill guideline that indicates a problem. The data are given in Table 22-1.

Operational and continuous stack monitoring data records are retained for five years. Unit efficiency is measured by time on-stream.

6.0 Cost Data

a. Capital Cost: TOF - $2,581,000 (1974). Capital cost of scrubber included. Detailed cost breakdown is not available.

b. O & M Cost: TOF - (1977)

Labor	$173,000
Parts & Materials	79,800
Contractual Repairs	12,800
Utilities	52,000
General Expense	5,700
Fixed Charges	178,200
Total	$501,500

c. Spare Parts Inventory

All Units	$ 61,000
TRS & SO_2 Monitors	3,000
Total	$ 64,000

d. Major capital and expense expenditures since installation:

Date	Thermal Oxidation Facility	
1975	A/C control room	$ 4,700
	Replace air stripper trays	22,400
1976	Instrument air dryer	6,400
1978	Additional spare parts	44,000
	Replacement SO_2 stack monitor	33,000
	Total	$110,500

e. Total pulp mill O & M cost: $22,665,000
Total mill air abatement O & M cost: $2,179,900
% TOF O & M vs pulp mill O & M: 2.2
% TOF O & M vs Total Air O & M: 23

TABLE 22-1. MONTHLY AVERAGE SO_2 VALUES AND HOURS GREATER THAN 100 PPM.

Date 1976	SO_2 Monthly Average	SO_2 Hrs. $\geq$100 ppm*
April	7.3	0
May	13.3	0
June	8.5	0
July	20.3	0
August	27.8	0
September	32.4	0
October	12.9	0
November	12.3	0
December	10.4	0
1977		
January	16.0	9
February	18.3	6
March	17.3	0
April	14.8	0
May	19.8	2
June	6.5	0
July	4.8	0
August	9.3	0
September	9.5	0
October	7.2	0
November	3.9	0
December	12.8	0

*100 ppm is mill guideline, not regulatory limit

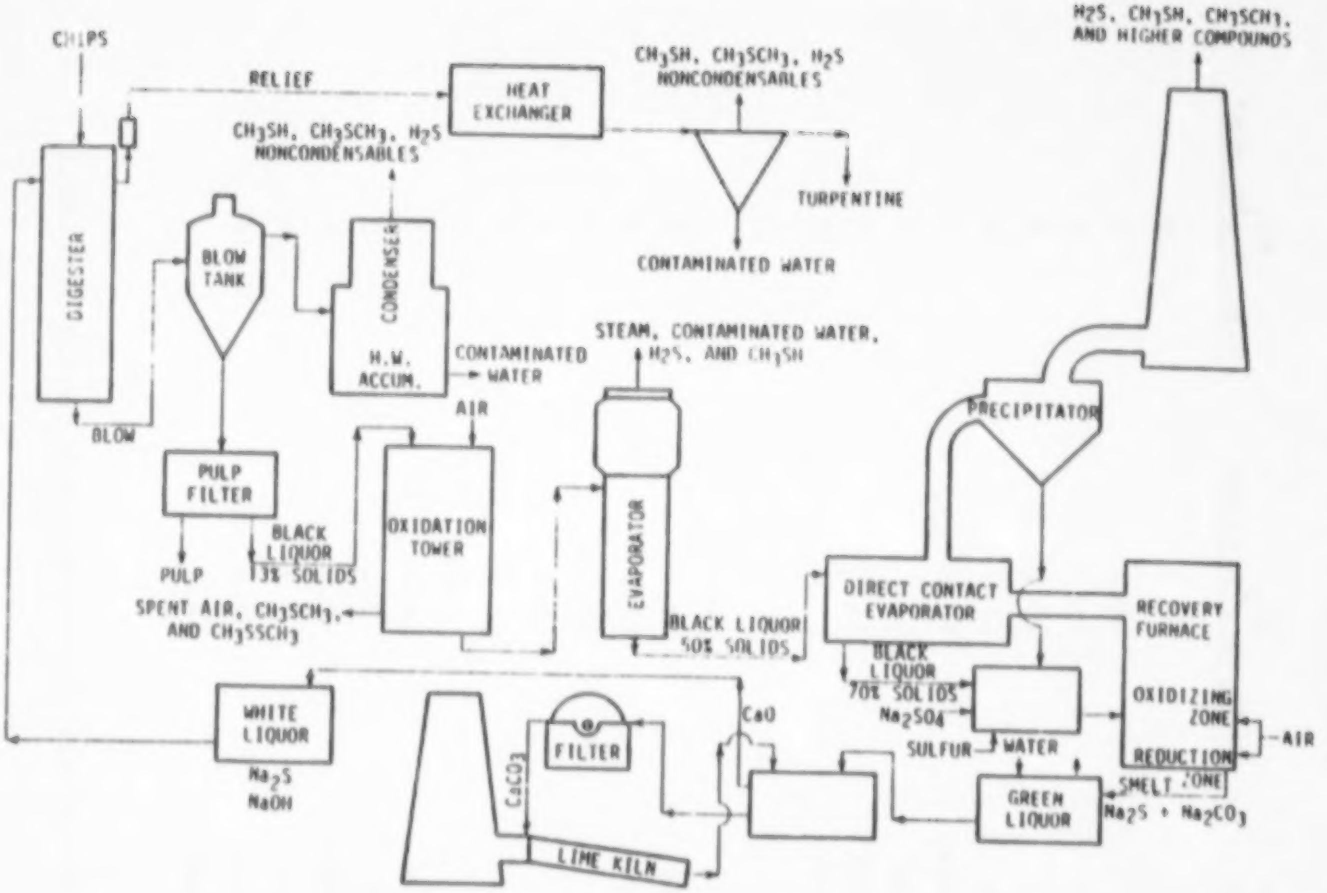
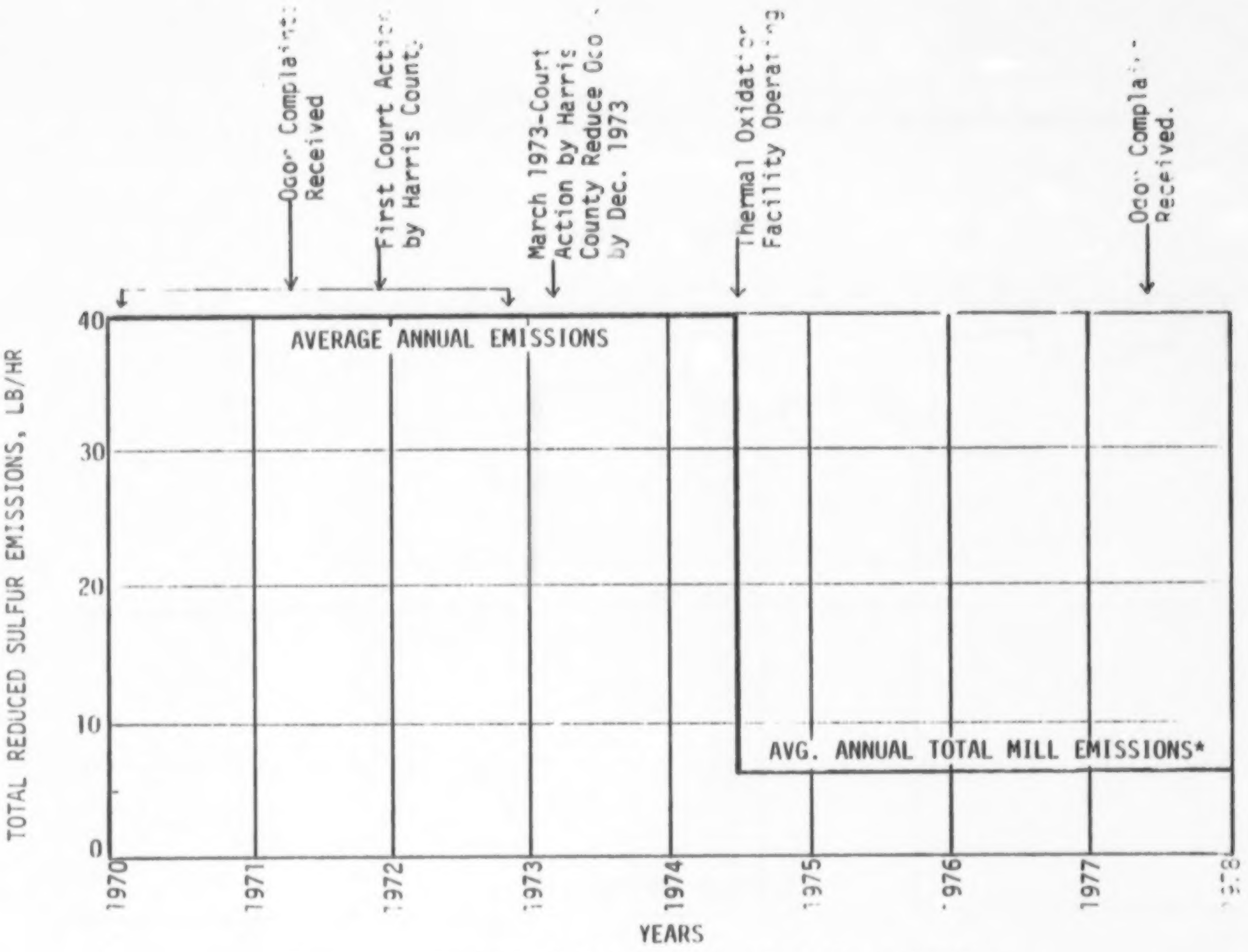

CHIPS
RELIEF
HEAT EXCHANGER
CH3SH, CH3SCH3, H2S NONCONDENSABLES
TURPENTINE
CONTAMINATED WATER
H2S, CH3SH, CH3SCH3, AND HIGHER COMPOUNDS
DIGESTER
BLOW TANK
CH3SH, CH3SCH3, H2S NONCONDENSABLES
CONDENSER
H.W. ACCUM.
CONTAMINATED WATER
BLOW
PULP FILTER
PULP
BLACK LIQUOR 13% SOLIDS
AIR
OXIDATION TOWER
SPENT AIR, CH3SCH3, AND CH3SSCH3
STEAM, CONTAMINATED WATER, H2S, AND CH3SH
EVAPORATOR
BLACK LIQUOR 50% SOLIDS
PRECIPITATOR
DIRECT CONTACT EVAPORATOR
BLACK LIQUOR 70% SOLIDS
Na2SO4
SULFUR
WATER
RECOVERY FURNACE
OXIDIZING ZONE
REDUCTION ZONE
AIR
SMELT
Na2S + Na2CO3
GREEN LIQUOR
WHITE LIQUOR
Na2S
NaOH
CaCO3
FILTER
CaO
LIME KILN

Figure 22-1 - Typical kraft sulfate pulping and recovery process.



* There is no legal limit for total mill TRS Emissions.

Figure 22-2. Thermal Oxidation Facility - Total mill TRS emissions, eight year profile.

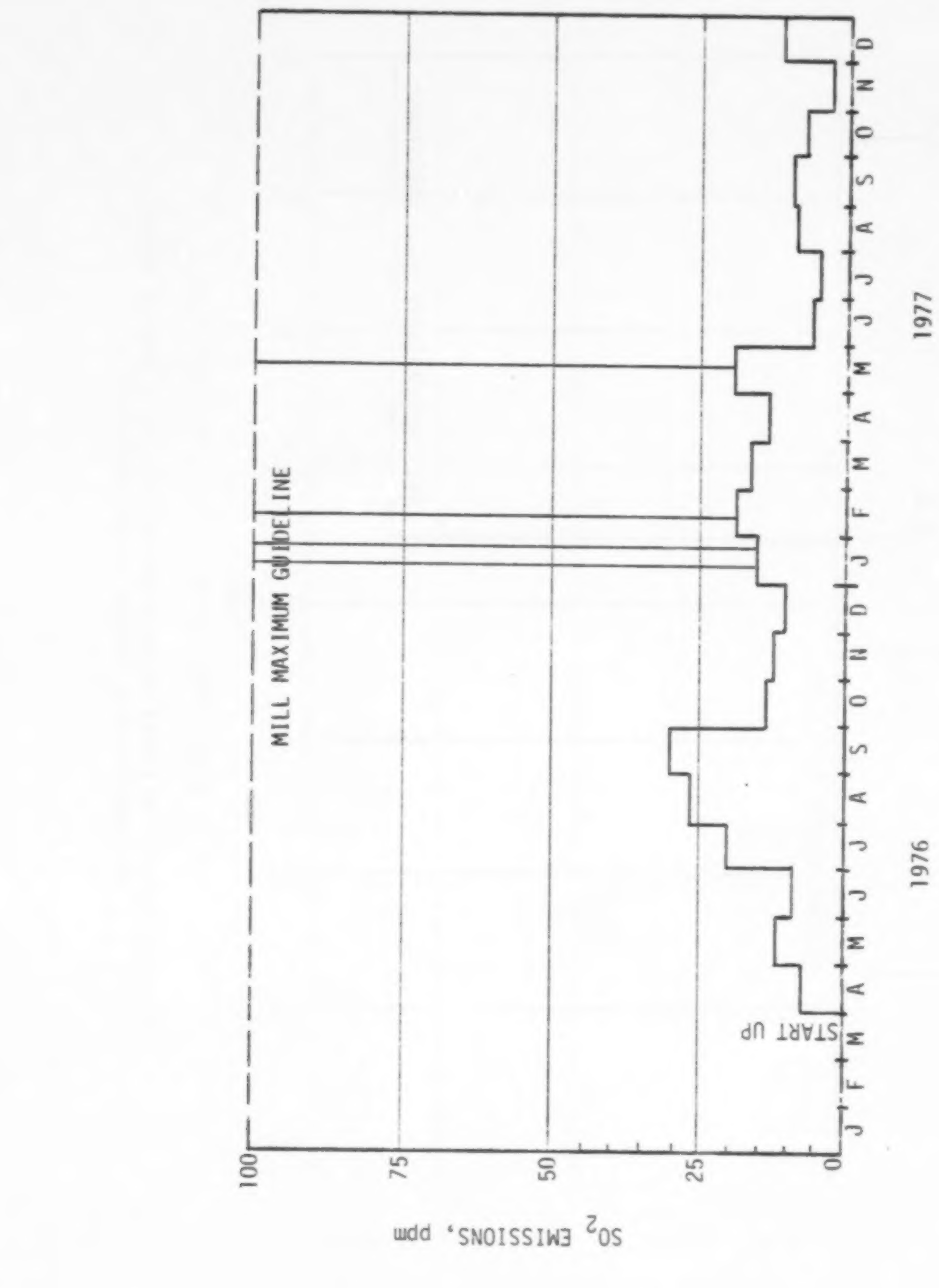


Figure 22-3. Thermal Oxidation Facility - monthly average SO_2 emissions for 1976 and 1977.

INSPECTION REPORT

Source 23

1.0 Summary of Visit

This plant constructed a fluid catalytic cracker unit (FCCU) in 1976 to replace two smaller FCCU's to fulfill the requirements of a court settlement. This unit was constructed as a new source under the TACB Permit Regulation. The air pollution control system is a new design that has not met design performance characteristics. This unit has been stack tested by the TACB sampling team, and it was not in compliance with the construction permit requirements. Neither is the unit meeting the opacity requirements of 20 percent maximum. The company spokesman admitted that the FCCU probably could not meet the requirements in its present status. He felt that the unit needed additional air pollution control equipment. In our opinion, the TACB should not have allowed the company to construct this unit without BACT equipment.

The city agency has recorded numerous instances of opacity violations as well as the stack test that showed the unit operating above regulatory limits. As yet there is no indication what legal action the city agency or the TACB might take.

2.0 Chronology of Source/Agency Interaction

1970-1973	City of Houston investigated numerous citizen complaints and issued many N.O.V.'s.
1973	City initiated court action to reduce particulate emissions.
1975-May	Final court settlement was reached on FCCU units. The company agreed to install a new FCCU by June 30, 1976.
1976-June	A six-month extension was granted to the source to complete the installation of the new FCCU.
1976-December	Installation of the new FCCU was completed.

1977-August	Application for an operating permit was submitted to the state agency.
1977-September	Results of TACB stack sampling tests showed that the source was not in compliance with the permit requirements. The operating permit was not granted.

3.0 Plant and Process Description

This plant is a medium size oil refinery with a crude oil feed capacity of 72,000 bbls/day. Processes at this facility include fractional distillation, fluid catalytic cracking, reforming, and sulfur recovery.

The process studied here is the catalyst regeneration unit (CRU) on the FCCU built and started up in 1976. It has a feed capacity of 50,000 bbls/day with a normal throughput of about 40,000 bbls/day. In this system catalyst recycles continuously for regeneration. In the cracking process a certain amount of coke builds up on the catalyst which renders it ineffective; this coke must be burned off to regenerate the catalyst. Particulates from the process are mostly catalyst fines that are generated in the fluid bed. Carbon monoxide, a product of incomplete combustion, is usually removed from the off-gas stream by burning it in a CO boiler for energy recovery. At this plant a new procedure is used whereby a portion of the CO is burned in the last stages of the regenerator to reduce its concentration to within air pollution regulation requirements. Catalyst fines are removed by two cyclones within the regenerator shell and two outside the shell in series. This new design for burning a portion of the CO in the regenerator has not operated satisfactorily, and it has contributed to many upsets within the regenerater. This problem has led to excessive particulate emissions.

The design specifications call for a shutdown of the FCCU every three years, whereas in actual practice the unit has been down two or three times per year. This has contributed to excess particulate emissions since it takes about two days to shut down the FCCU and three days to restart it.

4.0 Air Pollution Control Equipment

The FCCU and CRU were built in 1976, under Permit No. C-2501, using a new air pollution control design. The CRU uses two cyclones within the regenerator and two in series outside the shell to recover catalyst fines. A portion of the carbon monoxide is burned in the last stages of the regeneration cycle to help remove coke from the catalyst and to consume a significant portion of the CO, eliminating the need for a CO boiler. No additional equipment is installed between the cyclones and the stack except a turboexpander to help power the fan to conserve energy. Capital and operating costs were not available; the FCCU and CRU were built and installed along with the two external cyclones as a single system.

This system has not operated according to design air pollution control criteria and is not currently in compliance with the construction permit requirements. The opacity meter indicated 32 percent opacity during our visit; the operator said that the opacity is frequently over 30 percent. The company spokesman stated that it is likely that the CRU will have to be rebuilt or that more air pollution control equipment will have to be added before the unit can meet permit requirements.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

Maintenance on the air pollution control equipment has not been a big item. The cyclones are comparatively new and have not had any major repairs. The CRU has had several instances of overheating due to burning a larger portion of the CO than intended. This led to process upsets and excessive particulate emissions. Thus far there has been ample time to repair the air pollution control equipment while the FCCU was shut down.

One major repair was made when the special design fan failed. This fan is dual powered by a motor and the turboexpander. A three-month delay for a new fan resulted. After that the company repaired the old fan to use as a spare.

5.2 Emissions Data

Compliance test: Sept. 1977 - TACB stack tests

Date	Pollutant	Actual Emissions lb/hr	Allowable Emissions lb/hr
9/7/77	particulate	94.7	50
	SO_2	977	No limit
	H_2SO_4	16	952

The unit did not meet permit requirements for particulates. An operating permit has not been granted to date.

Sonics Inc. tested the stack on 2/11/77 and again on 2/24/77 with these results:

Date	Pollutant	Actual Emissions lb/hr	Allowable Emissions* lb/hr
2/11/77	particulate	213	99.4
	SO_2	690	No limit
	H_2SO_4	14	--
2/24/77	particulate	85	99.3
	particulate	60	99.3

*Sonics calculated the allowable limit from Regulation I, whereas the allowable limit in this case is the permit limit of 50 lb/hr.

Prior to December 1976 there were 2 small FCCU's. The following data were taken from the emission inventory forms in the TACB files.

Date	FCCU	Actual Emissions lb/hr	Allowable Emissions lb/hr
1973	A	46.7	60
	B	33	60
1975	A	63.2	60
	B	54	60

According to the city agency annual inspection reports these two units usually operated within the opacity limit of 30 percent but did not meet the CO requirements.

6.0 Cost Data

a. Capital Cost: $200,000 (estimated by company spokesman)
b. Operating Cost: Not available

The company spokesman said that the capital and operating costs could not be separated from the FCCU/CRU system since they were purchased and operated as a unit.

c. Spare parts cost: Not available

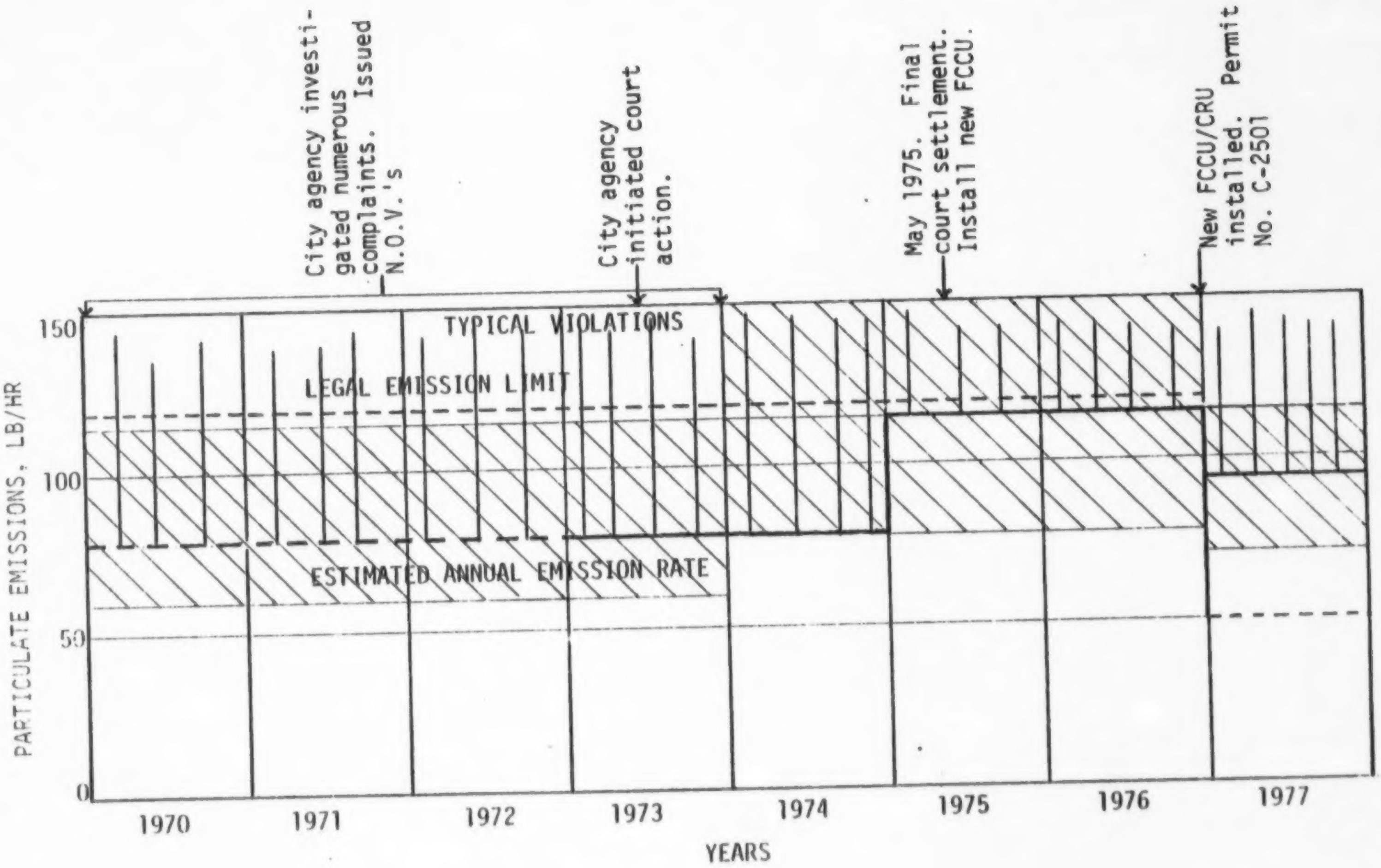


Figure 23-1. Multiple cyclones on FCCU/CRU.
Eight year emission profile

INSPECTION REPORT

Source 24

1.0 Summary of Visit

This company has an ESP to control particulate emissions (catalyst fines) from a catalyst recovery unit (CRU) that is an integral part of their fluid catalytic cracking unit (FCCU). The ESP was installed in 1970 in response to regulations that were adjusted by the TACB for that year. Over the years the company has made three principal efforts to improve the reliability and efficiency of the unit. Transformers were removed from the roof of the ESP to an air conditioned room, shielding the transformers from heat and vibration in order to improve ESP availability. Dust valves and hoppers were rebuilt, also to improve ESP system reliability. An ammonia injection system was installed to improve dust resistivity and resulting ESP collection efficiency.

The source is still subject to relatively frequent outages. One serious regulation violation occurred in March 1977 when the CO boiler was shut down for emergency tube repairs. It was discovered that a boiler bypass line had not been installed to the ESP. The unit was in violation of the opacity and particulate emission limits continuously for three weeks. The TACB sent a stern abatement letter to the company, but no follow-up action has been taken by the TACB to date.

2.0 Chronology of Source/Agency Interaction

1970	The company installed an ESP on the FCCU to comply with new TACB regulations.
1970-1972	TACB files showed the source to be in compliance with applicable regulations.
1973	Problems developed with the ESP. Some regulation violations were recorded by the city agency, and the company asked the ESP vendor to remedy the problems.
1975-June	FCCU gases were bypassed around the ESP, causing a three-week continuous opacity violation.

1975	Six N.O.V.'s were issued to source by the city agency.
1977	Twelve violations were recorded by the city agency, and several N.O.V.'s were issued.
1977-March	FCCU gases were bypassed around the ESP for three weeks during boiler repairs, resulting in a continuous opacity violation. The city agency sent an abatement letter to the company, but no further action has been noted.

3.0 Plant and Process Description

This plant, a large oil refinery with a feed capacity of 350,000 barrels per day, includes all of the usual refinery processes such as distillation, catalytic cracking, hydroforming, reforming, etc. The process studied in this report is the FCCU/CRU, with a feed capacity of 75,000 barrels/day and a normal throughput of 67,000 bbl/day. The catalytic cracking process converts certain heavier portions of crude oil into gases, gasoline blending stocks, and distillate fuels. Feedstocks to the FCCU are gas oils from atmospheric or vacuum crude oil distillation units, thermal cracking units, lube oil extraction and dewaxing units, and coking units. Catalytic cracking units are normally operated to produce a maximum of gasoline blending stocks, but the units are very flexible and operating conditions can be varied to maximize other products.

Both the cracking and regeneration sections operate on the fluidization principle which makes possible a continuous flow of catalyst to the regenerator where the catalyst is being constantly regenerated and returned to the cracking section. In the regenerator a controlled amount of air is introduced with the catalyst to burn the coke, which reheats the catalyst as it is cleaned. The combustion gases flow through a series of cyclone separators located inside the regenerator to remove most of the entrained catalyst fines.

The hot flue gases at about 538° C (1000° F) contain 5-10 percent carbon monoxide (CO) which is burned in a CO or waste heat boiler to recover a considerable amount of energy. The remaining catalyst fines can be removed from the gases by an electrostatic precipitator (ESP) or a third or fourth stage cyclone separator located outside the regenerator. At this facility an electrostatic precipitator is used after the CO is burned in a CO boiler. The efficiency of the ESP has been increased by injecting ammonia into the gas stream within the CO boiler.

4.0 Air Pollution Control Equipment

The CRU has a CO boiler and an ESP installed in series. The ESP was installed in 1970 on an existing CRU and the CO boiler was installed in 1953.

ESP design and operating data

Manufacturer:	Buell Manufacturing Co.
Gas Flowrate*:	410,000 acfm
Gas Temperature*:	630° F
Gas Pressure*:	10 inches of water
Particulate loading*:	0.12 gr/acf
Design efficiency:	92%
Actual efficiency:	85% (1974-75 data)

*At inlet of ESP

In general this ESP does a good job of removing the catalyst fines. The opacity of the exhaust gas at the stack outlet is normally 20 percent or less. Two things were done to improve the efficiency of the ESP. Ammonia is injected into the gas stream in the CO boiler to improve the collection efficiency within the ESP. The transformers were removed from the top of the ESP and placed at ground level in an air conditioned room. This move yielded a more constant supply of electricity to the ESP and reduced maintenance and repairs by eliminating vibrations associated with the operation of the ESP. New dust removal valves had to be installed at the bottom of the collecting bins. The latter two items were in effect design changes to improve efficiency and decrease downtime due to maintenance problems.

The company was critized by the regulatory agency for bypassing the ESP directly to the stack during an extended downtime of the CO boiler while replacing boiler tubes. It was found that no duct work was installed to bypass the CO boiler to the ESP. Even though the feed to the FCCU was decreased to 60,000 bbl/day the emissions exceeded 30 percent opacity for about three weeks. The company was found in violation of Regulation I but no court action had been initiated to date to set a fine.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

Not much information was available concerning maintenance procedures on this unit. The attitude of the company engineers was that the unit is maintained like all the other equipment. Electricians perform most of the repair work on the unit.

The unit is inspected at least once per shift by operators on the FCC unit. These inspections include electrical parameters, hoppers, opacity, and board room monitors. One section of the ESP can be shutdown for repairs while the other is operating.

Repairs on this ESP have been typical of this type of equipment. The transformers were moved from the roof of the ESP and put in an air conditioned room. Wires breaking and other problems associated with vibrations and general instability caused this move. The high voltage has been more stable after the move but recently cable leakage problems have arisen. Internal wires have broken and corroded many times to cause failures. The dust valves and hoppers were rebuilt. This unit is seven years old and repairs are generally more frequent now. The production engineer said the agencies are notified of upsets either in the process or the ESP about four times per month.

5.2 Emissions data

Stack tests in March 1977 by TACB staff showed the FCCU stack in violation of Regulation I (Section 105.1).

Date	Pollutant	Actual Emissions, lb/hr	Allowable Emissions, lb/hr
3/29/77	particulate	238	137
3/29/77	SO_2	816	No Limit
3/29/77	H_2SO_4	109	848

These tests were made during periods when the ESP was bypassed due to CO boiler repairs. This unit does not generally exceed Regulation limits during normal operation.

TACB staff stack samples April 1978.

Date	Pollutant	Actual Emissions, lb/hr	Allowable Emissions, lb/hr
4/19/78	particulate	76.2	134
4/19/78	SO_2	653	No Limit
4/19/78	H_2SO_4	17	830

No stack tests were available prior to 1977. The Emission Inventory files showed the following emissions for 1973 and 1975 for particulates.

Date	Average Particulate Emissions, lb/hr	Allowable Emissions, lb/hr
1973	50	135
1975	40	135

The TACB Region VII office personnel said this stack is considered to be in continuing compliance, but they have many upsets. In 1977 the regulatory agencies recorded 12 instances of opacity violations, and 5 in 1976.

6.0 Cost Data

a.	Capital cost:	$720,000 in 1970
b.	O & M cost;	$ 50,000 (1973) Current O & M cost not available
c.	Spare Parts:	No data available Spare parts are not inventoried for any particular unit but are included in facility inventory.

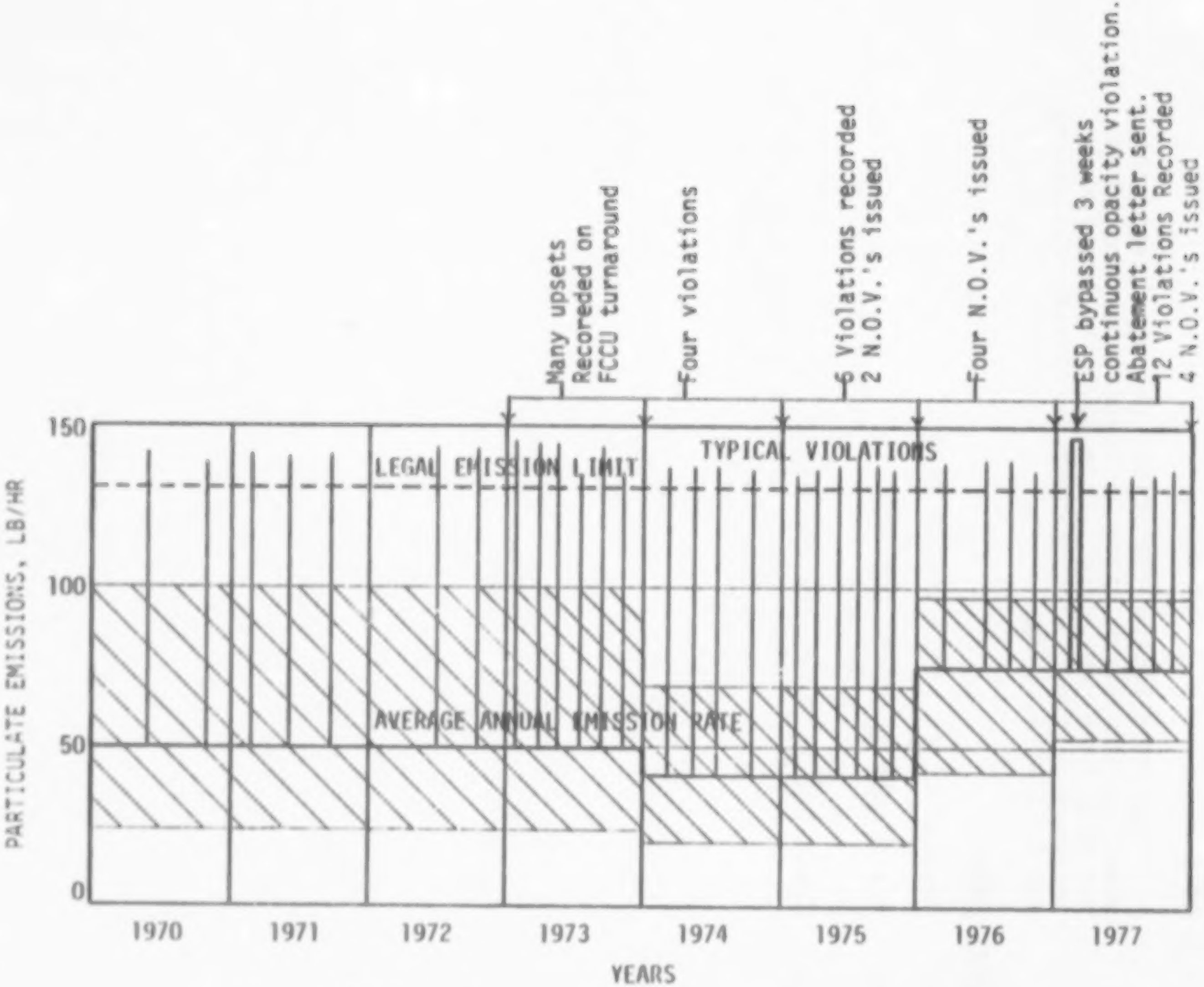


Figure 24-1. Electrostatic precipitator - FCC/CRU - eight year emission profile

INSPECTION REPORT

SOURCE 25

1.0 Summary of Visit

This company has operated an electrostatic precipitator (ESP) on an FCC unit for three years with only a few breakdowns. Opacity has been in the range of 0 to 10 percent for the majority of the time. The ESP was installed in May 1975 in response to a court order in 1974 requiring the company to eliminate excess emissions from the FCCU by May 31, 1975.

Prior to that time, only cyclones inside the regeneration unit shell were used for particulate control. Frequent excessive emissions occurred and the regulatory agencies recorded these many times. This led to the law suit in 1974.

Rationale for the installation of air control equipment was to comply with regulations.

2.0 Chronology of Source/Agency Interaction

1970-1973	Excess emissions at FCCU stack were recorded by all three regulatory agencies. Violations included excess opacity and particulate emissions.
1974	Harris county and TACB obtained a court order which stated the company must eliminate excess emissions at FCCU stack by May 31, 1975.
1975	June. ESP became operational at FCCU. Particulate emissions were reduced to a low level and opacity was reduced to near zero, in accordance with the court order.
1976	One excess opacity instance was recorded by the city agency.
1977	No violations were recorded. The TACB annual inspection report stated there had been no regulation violations by the source since May 1975.

3.0 Plant and Process Description

The company operates a medium sized oil refinery with a feed capacity of 100,000 bbl/day. The facility includes all of the usual refinery processes such as fractional distillation, hydroforming, fluid catalytic cracking, and sulfur recovery units. The fluid catalytic cracking unit (FCCU) has a fresh feed capacity of 48,000 bbl/day with a normal throughput of 45,000 bbl/day. Feedstocks for the FCCU are gas oils from atmospheric and vacuum crude oil distillation units, thermal cracking units, and lube oil extraction and dewaxing units. The FCCU is normally operated to produce a maximum of gasoline blending stocks, but the unit is very flexible, and operating conditions can be varied to maximize other products.

Both the cracking and regeneration sections operate on the fluidization principle which makes possible a continuous recirculation of catalyst to the regenerator. In the regenerator a controlled amount of air is introduced with the catalyst to burn the coke and to reheat the catalyst. The combustion gases flow through a series of cyclone separators located inside the regenerator to remove most of the entrained catalyst fines.

The hot flue gases at about 1000°F contain 5 to 10 percent carbon monoxide which is burned in a waste heat boiler to recover a considerable amount of energy. The gases are then passed through an ESP with a removal efficiency of about 93 percent for catalyst fines.

4.0 Air Pollution Control Equipment

Data for this ESP are as follows:

Manufacturer:	Research Cottrell
Air Volume:	290,000 acfm
Capital Cost:	$2.3 million (1975)
Design efficiency:	92-96.7%
Actual efficiency:	92.6%
Inlet Conc.:	0.046 gr/awcf
Outlet Conc.:	0.004 gr/awcf

This ESP was overdesigned purposely by 50 percent. It can be powered-up when an inlet dust load is anticipated. This equipment has been down for repairs only four times for one hour or more in three years. The unit has two separate chambers. Either one has the capability to keep the emissions within regulation requirements under normal process conditions while the other is shut down for repairs. The expected remaining life of the ESP is 15 years.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

This unit appears to be maintained very well. It is inspected at least once per shift by FCCU operators for electrical parameters, opacity, and all control room monitors.

Repair frequency is about once per month for minor repairs with no shutdown and once per year for major repairs requiring a shutdown. Shutdown times have been for 1 to 22 hours (four times) with an average time of 10 hours. This is an operating time of greater than 99.8 percent.

5.2 Emissions Data

The compliance test was conducted by the TACB on July 23-25, 1975.

Date	Actual Particulate Emissions, lb/hr	Allowable Emissions, lb/hr
1975	6.8 Avg	101
1977 estimate	8-10	101

Particulate emission level prior to installation of control equipment was 100-230 lb/hr (estimated by company engineer).

Emission inventory forms contained the following data:

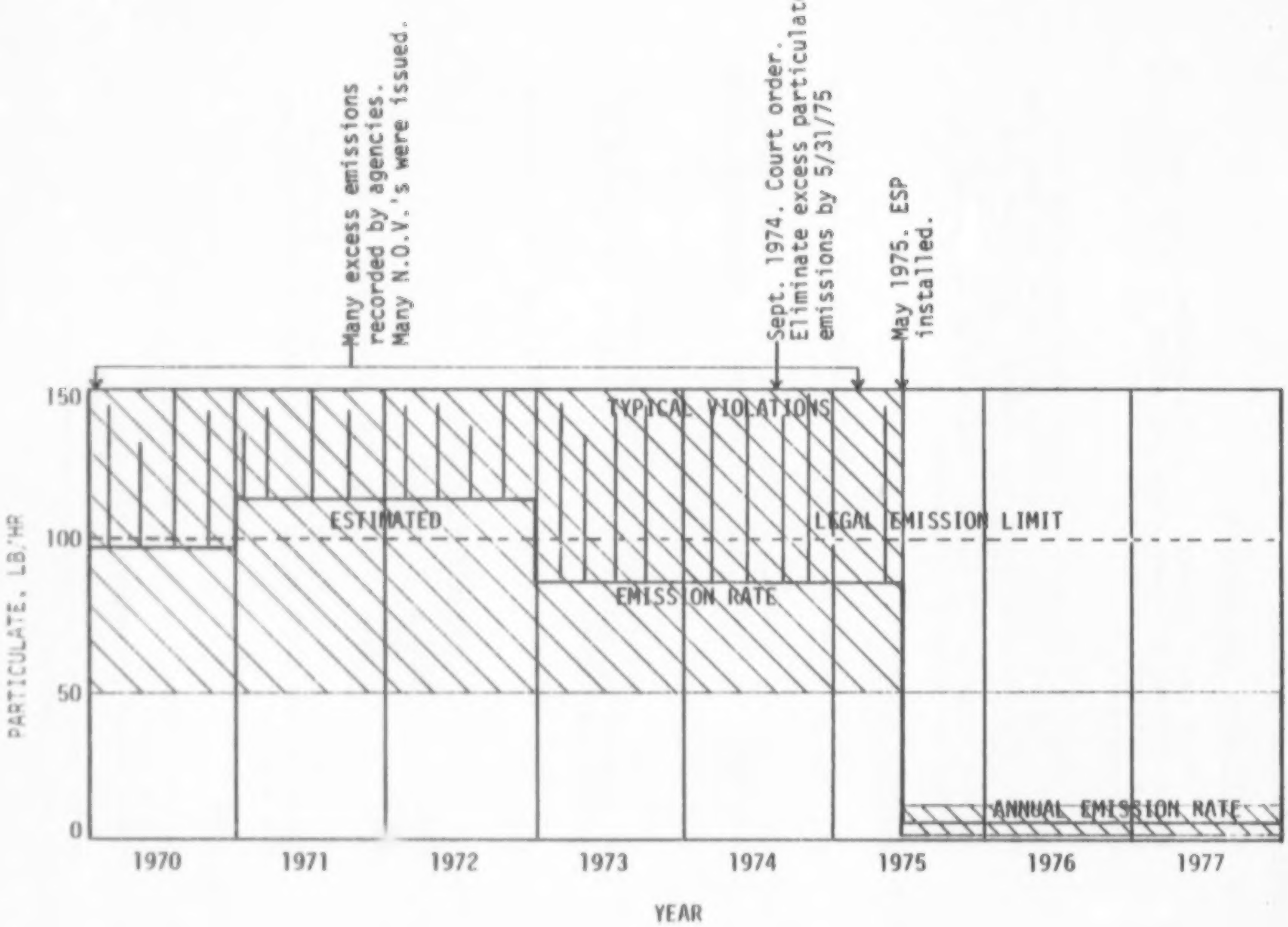
	Particulate Emissions	
Year	Ton/yr	lb/hr
1973	373	85
1975	254	59 (ESP installed in May.)

Prior to the installation of the ESP any type of upset in the FCCU would cause excessive emissions at the stack.

6.0 Cost Data

a.	Capital cost:	$2.3 million (1975)
b.	O & M cost:	$50,000 (1977)
c.	Spare Parts inventory:	$3,000

Parts include insulating bushings, rectifier parts, opacity meter parts.



Many excess emissions recorded by agencies. Many N.O.V.'s were issued.

Sept. 1974. Court order. Eliminate excess particulate emissions by 5/31/75

May 1975. ESP installed.

Figure 25-1. ESP at an FCCU. Eight year emission profile.

INSPECTION REPORT

Source 26

1.0 Summary of Visit

This air pollution control system, a catalyst recovery unit (CRU) on a fluid catalytic cracking unit (FCCU), also serves a valuable function in the recovery of catalyst from off-gases. The system consists of a series of mechanical separators and a scrubber. Inherent fine particle collection inefficiency results in a continuous stack opacity of 10 to 15 percent. Continual system deterioration necessitates major repairs approximately every six years to keep opacity below the regulatory limit of 30 percent. The system was rebuilt in early 1978.

Short duration (about five minutes) opacity excursions above 30 percent usually occur three times per day when the CO boiler tubes are cleaned by introducing a blast of sand to remove accumulated catalyst dust.

The reliability of this equipment is good, but process upsets cause excess opacity readings once in four or five days for 20 to 30 minutes. Excess emissions lasting longer than about five minutes are usually reported to the control agency, in accordance with Rule 7 - notification concerning upset conditions. Violation notices are not generally issued in such cases.

2.0 Chronology of Source/Agency Interaction

1963 - The company built a catalyst recovery system in response to economic product recovery incentive.

1972 - The TACB Region 7 office notified the company it would have to comply with new regulation limits in 1973.

1972 - The company repaired the system bringing it into compliance with emission and opacity regulations.

1974 - October. The TACB issued one N.O.V. for a short-term opacity excursion.

1975 - July and October. TACB inspectors issued N.O.V.'s for exceeding the opacity limit. Numerous Rule 7 notifications were sent by the company to city, county, and state agencies concerning upsets that caused excess opacity.

1975 - October. The company repaired the system to improve performance.

1976 - Only one N.O.V. was issued by the TACB this year. Numerous Rule 7 upset notifications to the city, county, and state agencies from the company were in the file. Annual inspection report by the state showed the source in continuing compliance.

1977 - Annual inspection report by the TACB stated that the source was in continuing compliance. Numerous Rule 7 upset notifications were in the TACB file. No N.O.V.'s were issued.

1978 - February. The company completely rebuilt the system to increase its efficiency.

The TACB Region 7 office and the city agency consider this oil refinery to be in continuing compliance. The inspection engineer at the TACB regional office said that the CO boiler stack is only marginally in compliance; that there were problems staying in compliance in 1975 through 1977, but the system was much improved at his last visit in mid-1978.

The company appears to have a good record of compliance with regulations. Several notices of violation were issued in 1975 which caused the TACB regional director to call the company to a conference to discuss the problems associated with the violations. A program was developed to investigate the discrepancy between agency visual readings and the company owned Lear Siegler continuous monitor readings. The results of these tests are reported in Section 5.3, Emissions Data. Both the company and the TACB tested the stack for particulate emissions and found the stack within compliance. In January 1976, during the FCCU shutdown, the catalyst recovery system was overhauled, and performance improved. A large number of Rule 7 and Rule 8 notifications were in the file, but usually no action is taken by the agency if the inspector feels that the company is doing all it can to minimize emissions during an upset or breakdown.

Prior to the installation of control equipment emissions were 5 to 6 ton/day compared with approximately 1.7 ton/day currently.

3.0 Plant and Process Description

This oil refinery processes crude oil to make products such as gasoline, benzene, toluene, ethylene, propylene, etc.

Refinery capacity is about 300,000 bbl/day; processes include fractional distillation, catalytic cracking, hydroforming, hydrodesulfurization, reforming, sulfur recovery, etc. The FCCU process feed capacity is 70,000 bbl/day. Catalyst is withdrawn continously and regenerated in the CRU. Two stages of cyclones (16 total) are integral with the regeneration unit, and a final separator is located outside the CRU.

4.0 Air Pollution Control Equipment

The air pollution control/catalyst recovery equipment for the off-gases from the catalyst regeneration unit is a company-designed and constructed system. It consists of a main separator, two classifiers, two catalyst hoppers and a water scrubber unit. The main separator consists of swirl-vane dry classifiers that separate about 90 to 95 percent of the particulate matter larger than 10 microns in diameter from the gas stream before the gas passes through a turbine and CO boiler and out the exhaust stack. Particles in the gas stream to the CO boiler are 99 percent smaller than 10 microns.

The separated particulates and about four percent of the gas stream are admitted to the catalyst recovery system consisting of a series of swirl-vane classifiers that separate about 90 percent of these particles from the gas. The particles are collected in hoppers and returned to the regenerator. The gas and approximately 10 percent of the particulate matter are admitted to a spray-tower, baffle-type water scrubber where 50 to 80 percent of these particles are removed from the gas stream. The exit gas stream is recombined with the main gas stream to the heat recovery boiler. Figure 26-1 is a schematic diagram of this system.

The company chose to use this type of equipment instead of an ESP to minimize downtime and maintenance problems. They reasoned that complete dependence on an ESP might cause them to have to shut down the process when the ESP was down. Besides, the ESP capital cost would be more, and they felt they could meet regulations with this system at much lower cost and at higher reliability. When this system is operating properly it does meet the regulations easily. However, this system will always have a background opacity of 10 percent or higher because there is essentially no control of particles smaller than 10 microns in diameter.

When the catalyst recovery system was repaired in 1978, the scrubber was redesigned to increase its efficiency; bypass lines were installed so that the gases from any part of the system could be bypassed to the scrubber. The company spokesman was very enthusiastic about the modification which will help to prevent excess emissions during maintenance.

5.0 Performance Evaluation

5.1 Maintenance

Major repairs to the system are made every six years, and planned maintenance is done every six months. One of the biggest maintenance problems is plugging of the fourth-stage classifiers, usually requiring three to four hours for repairs. Previous to the latest rebuilding in Febuary 1978, this problem always caused an excess opacity excursion. During the latest rebuilding, a bypass system was added that allows the gases from any point to be bypassed to the scrubber; this has nearly eliminated excess opacity during minor breakdowns. Excursions that cause excess emissions longer than five minutes are usually reported to the control agency in accordance with TACB general rule 131.01.00.007. This rule states that a source must notify the local regulatory agency and the TACB when a major upset occurs which causes or may cause an excessive emission. An excessive emission is not a violation if the source properly notifies the regulatory agencies and uses diligence in controlling emissions.

5.2 Instrumentation

The opacity of the gases in the exhaust stack is continuously monitored by a Lear Siegler optical transmissometer model No. RM-4. A second Lear Siegler instrument (model No. 20-610), installed in 1974, converts optical density to opacity. An earlier model Lear Siegler opacity meter was installed in 1968 to help the company comply with regulations passed in 1967. The separator equipment was rebuilt in 1972 after the opacity monitor indicated compliance problems. System repairs brought the source into continuing compliance until problems were encountered again from 1975 through 1977. In the first half of 1975 production was cut back by 10 to 15 percent to keep the process in compliance.

5.3 Emissions Data

Personnel from the TACB Region 7 office stack-tested this source in December 1975 and July 1977 and found it to be in compliance at 80 to 90 percent of the allowable emission rate.

The company also tested the stack during this period utilizing Southwestern Laboratories, Houston, Texas. The following data were obtained:

Date	Particulate Emissions, lb/hr	Allowable Emissions, lb/hr	Percent of Regulation	Opacity Percent
11/11/75*	142	168	85	24
11/11/75*	148	168	88	17
11/11/75*	153	168	91	18
12/18/75**	134	168	80	20
12/18/75**	139	168	83	27
07/14/77**	115			25
07/14/77**	111			24
07/15/77**	107			23
07/19/77*	121			26
07/19/77*	114			23
07/25/77*	110			26

* Southwestern Laboratories
** Texas Air Control Board

A series of tests was conducted to correlate visible emission readings by agency personnel with opacity meter readings. These tests correlated reasonably well in that all were grouped around 20 percent except the readings from the top of the FCCU, which shows the importance of background and distance from the stack.

Date	Opacity Reading by Agency Inspector At Ground Level, %	Opacity Reading by Agency Inspector At top of FCCU, %	Opacity Meter Reading, %
11/10/75	22	11	19
11/21/75	24	7	15
12/09/75	19	5	19
1/15/76	19	10	18

Continuous opacity data are obtained with a Lear Siegler continuous opacity monitor. The daily opacity charts were reviewed for 1976 and 1977. The daily average values for 1976 and 1977 were plotted along with monthly averages for 1975 through 1977 and estimated annual averages for 1972 through 1974. The typical daily opacity chart shows frequent spikes due to depressurizing the catalyst tanks after catalyst transfer and longer duration spikes due to boiler tube cleanup. Neither of these are regulation violations. An approximate correlation curve between particulate emissions and opacity is shown also. Figures 26-2 through 26-5 are:

- daily average opacity for 1976 and 1977,
- typical daily opacity,
- seven year opacity profile, and
- an approximate correlation curve, opacity vs emissions in lb/hr.

6.0 Costs

6.1 Capital Costs

This system cost about $250,000 to build in 1963, and $85,000 to make major repairs in 1967, besides lesser repair costs.

6.2 Operating Costs

Operating cost of the catalyst recovery and air pollution control units was estimated by the company at $70,000 per year.

Total air pollution control expenditures for the entire refinery facility are given by years.

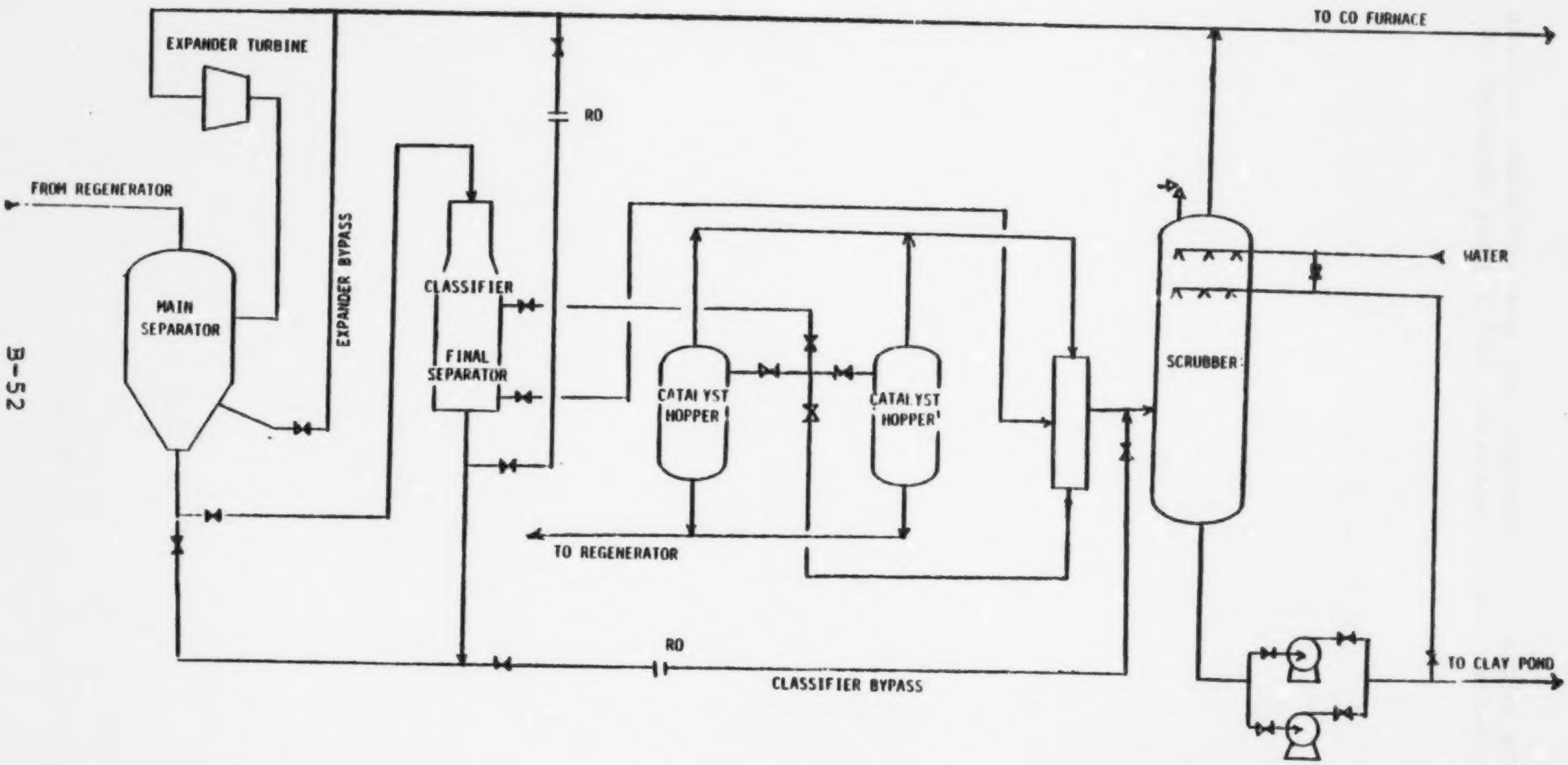
Year	Total APC Capital	Total APC Operating
1975	$10 million	---
1976	$ 400,000	$5 million
1977	$ 437,000	$6 million

It was reported that total APC operating expenditure was about 15 percent of total facility pollution control operating expenditures.

6.3 Spare Parts

Spare parts inventory for this system was estimated by the company to be approximately $5,000. A plant representative indicated that it is not necessary to carry large items in the spare parts inventory because the parts are rebuilt by the machine shop when they wear out. One spare swirl-vane is kept in inventory.

Spare parts in inventory for the scrubber include solenoid valves, spray nozzles, and a pump mounted in place.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MAIN SEPARATOR
CLASSIFIER
FINAL SEPARATOR
CATALYST HOPPER
CATALYST HOPPER
SCRUBBER
WATER
TO REGENERATOR
RO
CLASSIFIER BYPASS
TO CLAY POND

Figure 26-1. Catalyst recovery system

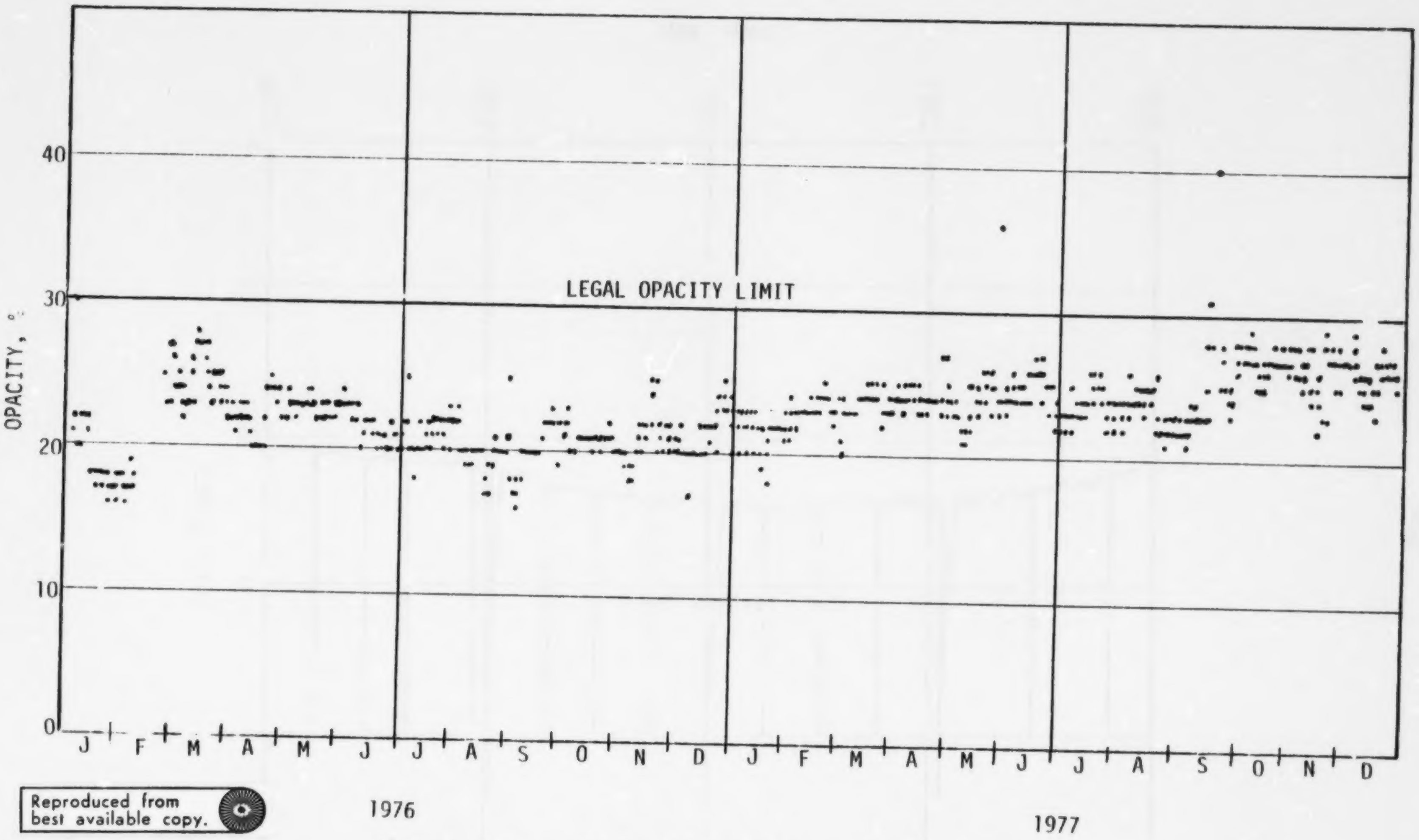

Figure 26-2. FCCU stack - daily average opacity for years 1976 and 1977.

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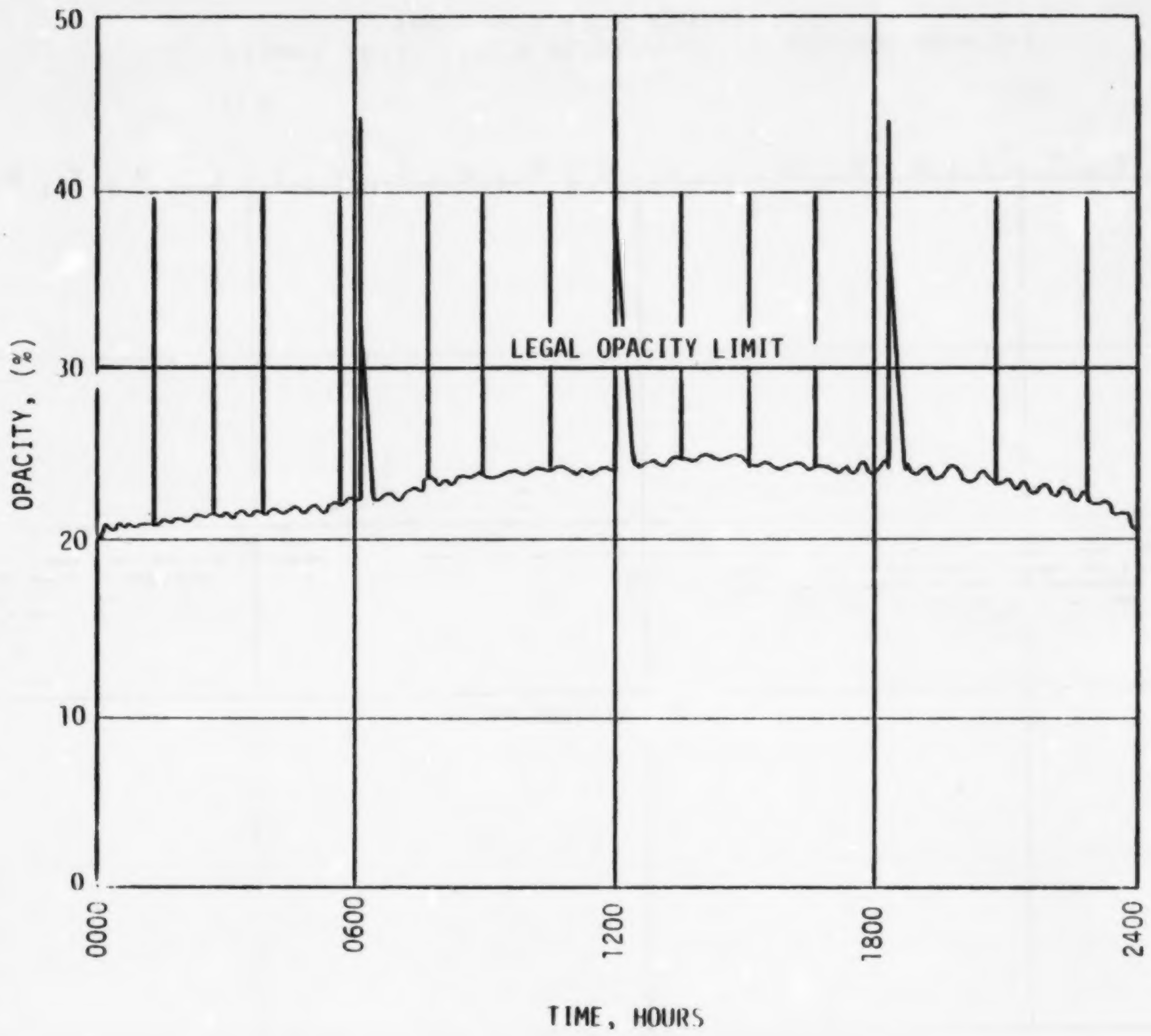

Figure 26-3. FCCU stack - typical daily opacity chart.

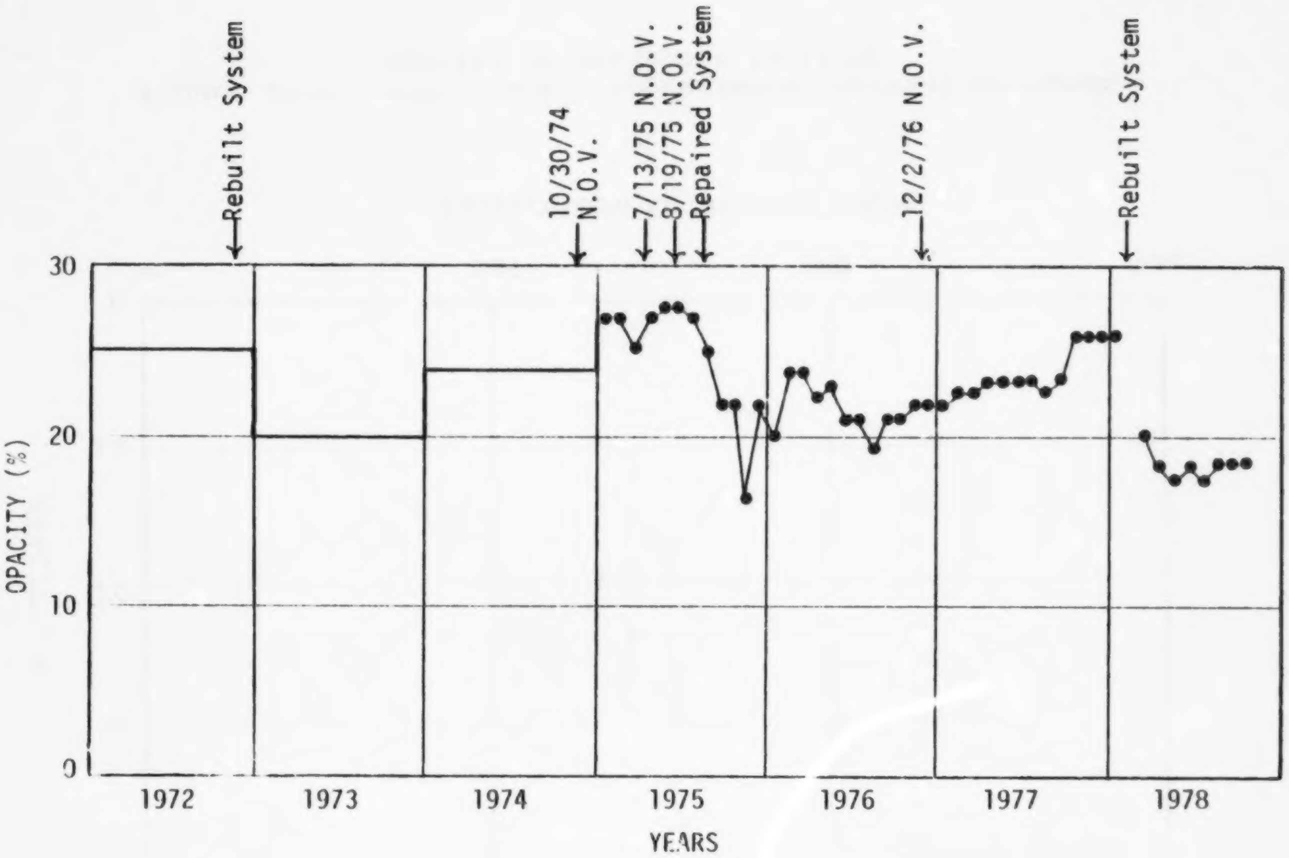

Figure 26-4. FCCU stack - seven-year opacity profile.

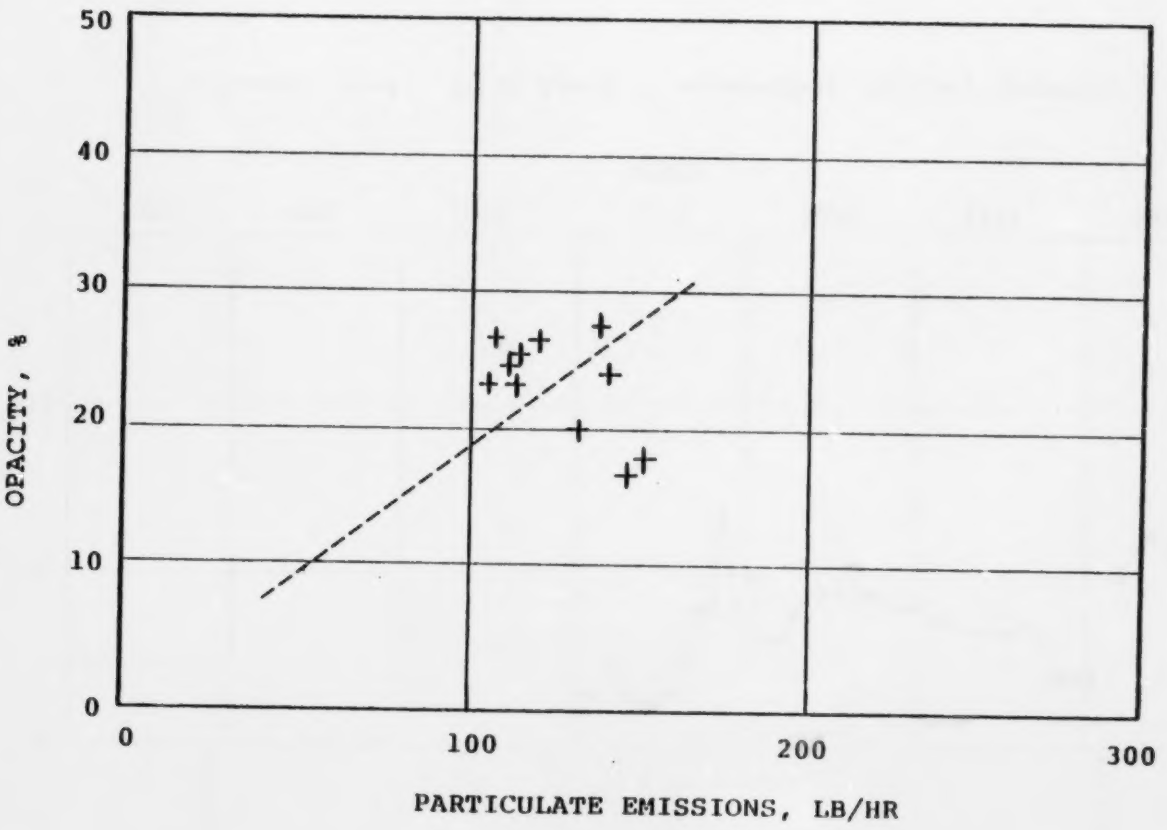

Figure 26-5. FCCU stack - approximate correlation curve opacity vs emissions in lb/hr

INSPECTION REPORT

Source 27

1.0 Summary of Visit

This company has operated a Shell Claus Off-gas Treater unit (SCOT) since June 1976 on a Claus sulfur recovery unit that was previously installed just one year earlier. The SCOT has reduced SO_2 emissions from 5000 ppm to an average of 250 ppm and has enabled the company to operate within permit limits almost continuously. Since 1972 SO_2 emissions have been reduced from 5,000 ppm to 250 ppm. The regulatory agencies are pleased with this progress. This unit has been shut down for repairs for seven weeks in 2 years but the regulatory agencies have not issued any notices of violation since sources are legally allowed to operate for short periods above the limits during upsets and emergency repairs.

2.0 Chronology of Source/Agency Interaction

1970-1973	The company operated four Claus units in compliance with regulations.
1975	The company installed one 300 ton/day Claus unit to replace two of the smaller units and reduced the SO_2 emissions by 15 percent.
1976	The company installed a SCOT unit to treat the Claus off-gases and reduced the SO_2 emissions from the new Claus unit by 95 percent.
1977-1978	The SCOT unit has operated successfully with only a few weeks downtime.

3.0 Plant and Process Description

The sulfur recovery unit is a part of a complete oil refinery which converts crude oil to finished products such as gasoline, jet fuel, benzene, toluene, light distillate, etc. The refinery has a feed capacity of approximately 300,000 bbl/day of crude oil and it includes all the usual refinery processes such as fractional distillation, cat cracking, hydroforming, hydrodesulfurization, sulfur recovery units, etc.

The Claus sulfur recovery unit was a big step forward in air pollution control when it was introduced in the mid 1950's by converting 90-95 percent of the H_2S rich waste gases to sulfur and burning the remainder to sulfur dioxide. However, the tail gases from this unit would typically contain 10,000 ppmv of sulfur dioxide which could cause a pollution problem. So the tail gas treatment processes were developed which convert the sulfur dioxide back to H_2S and convert this to sulfur by another process or admit the H_2S rich stream to the claus unit feed.

4.0 Air Pollution Control Equipment

The air pollution control equipment in this study is the Shell Claus Off-gas Treater (SCOT). This unit essentially reduces all of the sulfur compounds to H_2S and removes this from the air stream in an amine absorber from where it is introduced to the feed stream of the Claus unit. The SCOT is designed to operate at 500 ppmv sulfur dioxide in the exit gases whereas current operation yields an average of about 250 ppmv. The inlet concentration is about 4,000 ppmv. The volume of Claus off-gas feed to the SCOT is 15 million cubic feet per day (10,400 acfm). The unit was built in 1976 to treat the off-gases from a new 300 ton/day Claus unit built on a construction permit in 1975 under TACB Regulation VI requiring BACT for the Claus unit. The SCOT consists of the following units: mixer, catalytic reactor, wasteheat boiler, quench tower, H_2S absorber (amine tower), H_2S stripper.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

The unit is scheduled for an inspection/maintenance shutdown every 3 years. Routine maintenance is on an as-needed basis by daily operator inspections and by indications from process variables which are monitored in the control room.

The SCOT has been shutdown for repairs three times since startup for a total of 7 weeks. Total cost of repairs was $20,000 - Better maintenance and inspection procedures probably would not have prevented these shutdowns. Since the processes comprising the SCOT are standard refinery type operations the operating and maintenance people are familiar with the equipment and can do a creditable job on routine inspection and maintenance.

The repairs on the SCOT unit to date are summarized below.

Date	Reason for Shutdown	Repair Time	Repair Cost
11-76	Sulfur carry over from Claus	3 weeks	$ 5,000
8-78	Repair weak spot in refractory lining	3 weeks	$ 5,000
9-78	Expansion joint failure	1 week	$10,000

5.2 Emission Data

In normal operation the SCOT unit operates well below the permit limit of 800 ppmv sulfur dioxide.

Compliance Test: 7/30/76

Actual emissions:	191 ppmv SO_2	(424 lb S/day)
Allowable emissions:	800 ppmv SO_2	(1776 lb S/day)

A continuous SO_2 monitor is mounted in the SCOT exhaust stack. Once each 4 hours the SO_2 reading is punched into the computer which yields a printout with daily and monthly average readings. From these computer printouts we recorded daily and monthly averages, and plotted the data in Figure 27-1.

The SO_2 stack gas analyzer is a Beckman IR type. This unit has automatic zero set and is manually filter checked once per day, and span gas calibrated once per 2 weeks. Accuracy is approximately ± 10 percent.

6.0 Cost Data

Capital Cost:	$7 million (1978 dollars)
Annual O & M:	$644,000
Spare Parts Inventory:	$20,000

Spare parts include expansion joints, analyzer parts, motors, pumps, and general hardware parts sized for this unit.

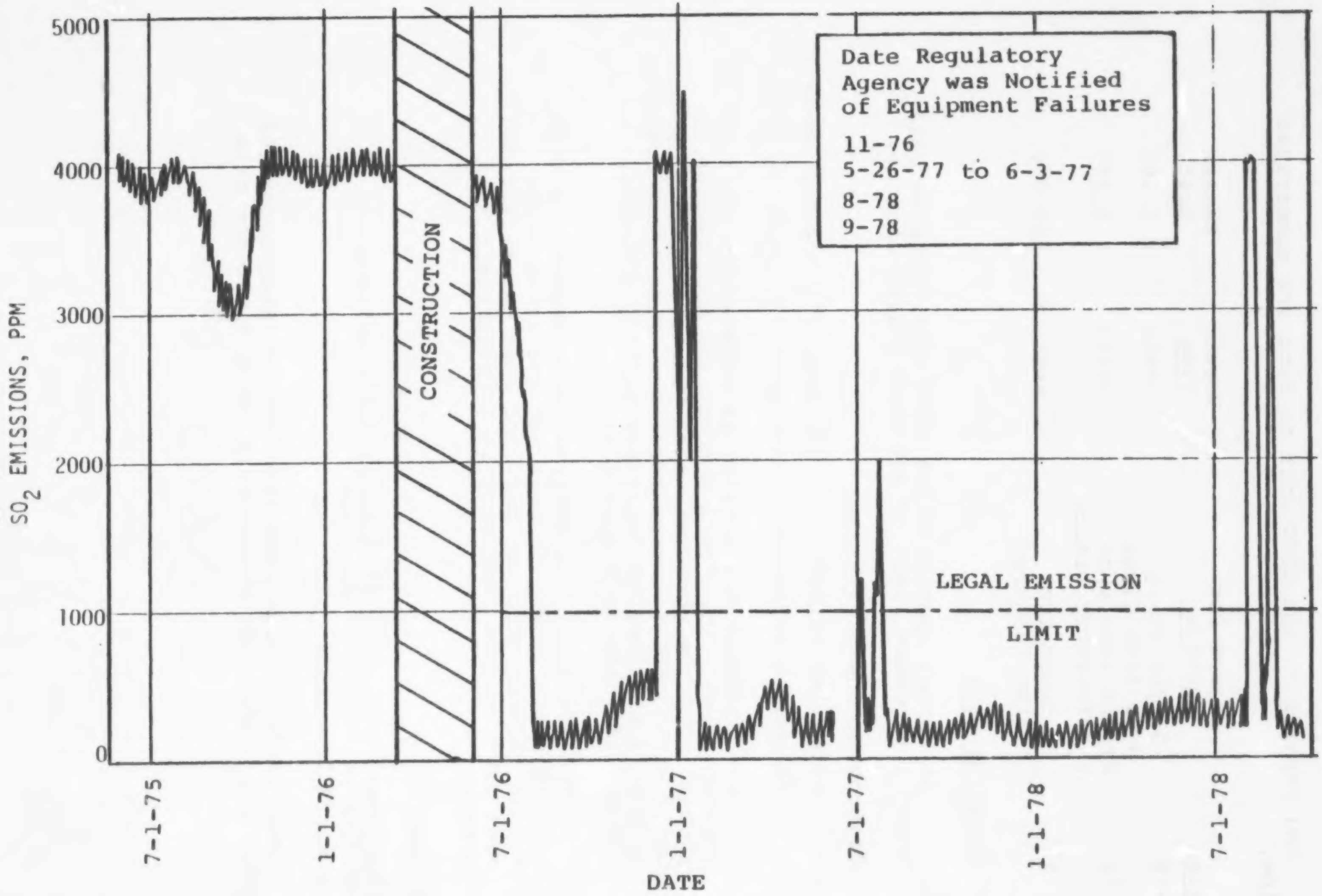

Figure 27-1. SCOT unit SO_2 emission - three-year profile.

INSPECTION REPORT

Source 28

1.0 Summary of Visit

This plant operates three rotary kilns to manufacture portland cement. A single stack serves all three kilns. The plant capacity is 2000 tons per day, and annual production is about 500,000 tons. Consequently one or more kilns are shut down much of the time. When a kiln is just starting up, opacity and particulate violations are more probable because the product is hygroscopic and has a tendency to stick to the walls when the kiln cools. On start-up, this material dries and is easily removed from the walls creating a surge of solids up the stack. This can overtax the precipitators and cause the opacity in the stack to exceed 30 percent. When this happens the source is required to notify the city, county, and state regulatory agencies and to make an immediate effort to correct the situation. This industry appears to have many start-ups and shutdowns.

2.0 Source/Agency Interactions

1974-1977	Many Rule 7 and 8 notifications were in the TACB file (100-200 each year). In addition 6 to 10 N.O.V.'s were issued by the city agency per year.
1978	Approximately 200 Rule 7 and 8 notifications were in the TACB file for upset conditions and emergency repairs. The city agency issued 6 N.O.V.'s to the company. There is no indication in the files that the source is in non-compliance.

3.0 Plant Description

The product produced at this facility is portland cement. The raw materials are oyster shells, clay and gypsum. The oyster shells are obtained from a company owned dredge in Galveston Bay and the clay from a pit near Pasadena, Texas. The gypsum is purchased.

In the process the shells are ground, screened, and then blended with the clay. The mixture is slurried with water and passed into a natural gas-fired rotary kiln. The product from the kiln is passed through a rotary cooler, blended with gypsum and then ground to produce portland cement. There are three rotary kilns in operation with a common stack servicing all three. Figure 28-1 is a process flow sheet.

4.0 Process and Control Equipment Design Evaluation

Only particulate emissions from this source are subject to emission control. Particulates are controlled by electrostatic precipitators. The initial installation consisted of three precipitators designed by Buell Engineering Company and installed in 1957. The design rate for each unit was 150,000 acfm with a design efficiency of 96 percent. In 1968, these units were modified to accommodate a throughput of 175,000 acfm each. In 1971, a Wheelabrator electrostatic precipitator was installed to operate in series with the three parallel Buell units. The design gas flow rate is 525,000 acfm; total system design efficiency is 99.5 percent.

5.0 Performance Evaluation

5.1 Maintenance Program

A scheduled maintenance period of two weeks per year is set aside for each kiln. The Buell precipitator for each kiln is overhauled while the kiln is down. The Wheelabrator precipitator can be shut down on a half-on half-off basis since each half has two fields. The Buells have only one field so they are either up or down. With the plant operating on a 330 day per year basis, unscheduled outages are usually for short periods of time. Plant management estimated that failure of air pollution control equipment costs about 5 percent of annual production or 25,000 tons of cement per year.

Common failures of the air pollution control equipment include short circuits in the system due to wire breakage, failure of the drag chain causing the collected dust to fill up the precipitor, and failure of equipment conveying the collected dust from the precipitators to the storage elevator. The Buell precipitators have flat bottoms; the company spokesman stated that they would never buy another flat bottom precipitator because of problems with the associated drag chain conveyors.

5.2 Recordkeeping

The opacity is continuously monitored and recorded.

5.3 Emissions Data

This unit has been stack tested only once by an outside contractor when only 2 kilns were in operation.

	Actual Emission	Allowable Emission
Stack Test	34 lb/hr	169 lb/hr

When all three kilns are operating the emissions are estimated to be about 50 percent higher or 50 lb/hr. The estimated accuracy of this value is ± 100%.

The TACB files contained only one emission inventory (1973), which indicated an annual emission rate of 21 lb/hr.

The above emission values are reflected in the emission profile.

5.4 Other Comments

This unit apparently meets applicable mass emission standards, but frequent opacity excursions (upsets) indicate that better control equipment is necessary. Although there is no indication of noncompliance in the TACB files, there is a very real question in our minds that a source who has to report 200 upsets per year is really adequately controlled.

6.0 Cost Data

A. Capital Costs

1.	1957 Three Buell ESP's	$1,370,000
2.	1968 Modifications to ESP's	95,000
3.	1971 Wheelabrator ESP	2,280,000
	Total	$3,645,000

B. Operations and Maintenance Budget

1.	Parts	$ 67,000
2.	Labor	76,000
3.	Power	110,000
	Total	$253,000 per year

C. Spare Parts Inventory - $25,000

Parts include:

1. Rapper parts
2. Emitting electrodes
3. Collector plates
4. Motors and drag chains

D. Cost per ton of product at 500,000 ton/yr

1. O & M - 50¢
2. Capital Cost - 30¢ (Assumes Buell ESP's to be fully depreciated, 15 year life for the Wheelabrator ESP.)

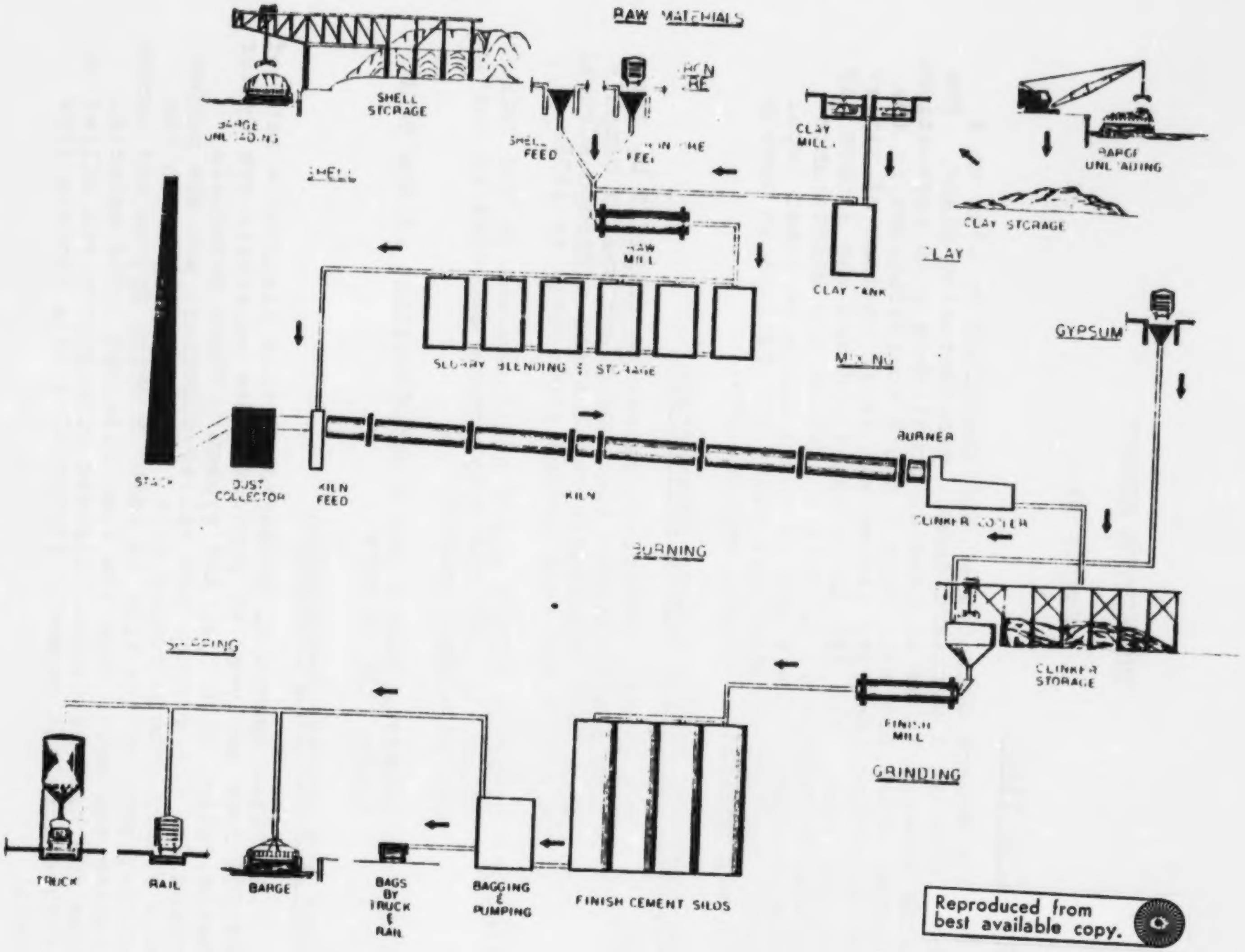
RAW MATERIALS
BARGE UNLOADING
SHELL STORAGE
SHELL FEED
IRON ORE
IRON ORE FEED
SHELL
CLAY MILL
BARGE UNLOADING
CLAY STORAGE
RAW MILL
CLAY TANK
CLAY
SLURRY BLENDING & STORAGE
MIXING
GYPSUM
BURNER
STACK
DUST COLLECTOR
KILN FEED
KILN
CLINKER COOLER
BURNING
SHIPPING
CLINKER STORAGE
FINISH MILL
GRINDING
TRUCK
RAIL
BARGE
BAGS BY TRUCK & RAIL
BAGGING & PUMPING
FINISH CEMENT SILOS

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Figure 28-1. Flow chart - Portland cement manufacturing

INSPECTION REPORT

Source 29

1.0 Summary of Visit

This source operates an ESP installed in 1962 on a rotary kiln at a portland cement manufacturing plant. The source appears to be in general compliance with regulations although there are many Rule 7 and 8 notifications in the TACB files and the city issues six to 10 notices of violation per year. The ESP is 16 years old and the source had difficulty keeping it in full operation and maintenance costs are high. There are no court suits or other legal actions pending against this plant for failure to comply with air pollution control regulations.

2.0 Chronology of Source/Agency Interaction

1975	The annual inspection report on 10/22/75 by the city agency stated that the plant was in compliance with applicable regulations although several N.O.V.'s had been issued previously in 1975.
1976-1977	Numerous Rule 7 and 8 notifications in the TACB files. In 1977 the city agency recorded 10 instances of excess opacity.
1978	Numerous Rule 7 and 8 notifications in the TACB files (130 in 1978).

3.0 Plant and Process Description

Portland cement is produced at this plant at a rate of 300,000 tons per year of product. Raw materials are oyster shells, clay, iron ore, and gypsum. These materials, except for the gypsum, are milled together, and are pumped as a slurry into a rotary kiln. The temperature in the burning zone of the kiln is 2800° F which drives off carbon dioxide and water from the feed material. The material from the kiln is cooled, blended with gypsum and milled to produce portland cement. Figure 20-1 is a process flow sheet.

In May 1977 the plant began to supplement natural gas with petroleum coke for fuel. In subsequent tests the percentage of coke and refuel (40 percent coal, 60 percent coke) were increased up to 100 percent without any adverse effect on the product. Since December of 1977 natural gas has been used only as a starting fuel.

4.0 Air Pollution Control Equipment Design Evaluation

The ESP was installed at plant start-up in 1962. The design efficiency was 98 percent and the design gas flow rate was 200,000 acfm. The unit was built in two sections with three compartments in each section. One section can be shutdown for repairs while the other is operating. This unit appears to have adequate capacity and when operating normally allows the source to meet regulation requirements. However, the unit is 16 years old and has frequent breakdowns. This along with frequent process upsets causes the source to be out of compliance many times during a year.

Performance is continously monitored and recorded, using a Bailey opacity meter, a Bailey combustibles analyzer, a Bailey oxygen analyzer and a DuPont SO_2 analyzer. The charts are stored in the office area for three to four years, but the data are not on computer cards or tape.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

The plant operates about 330 days per year. Typically there are six to eight scheduled shutdowns in a year. Emergency shutdowns are frequent; about two per month for the kiln and one or two per month for the ESP. Typical problems with the ESP have been wires breaking, rapper problems, and the screw conveyor not working properly. The source spokesman said they would not buy another ESP with a screw conveyor for dust removal. The dust collected in the ESP is removed by a screw conveyor which delivers to a cross conveyor which conveys the dust to the storage tank. This dust is recycled to the process when the ESP is operating normally but not when the ESP is partially down.

Spare parts kept on hand by this plant include screw conveyors, a bucket elevator, rappers and wire. Much of the down time is required to allow the unit to cool before it can be serviced.

5.2 Emissions Data

The plant usually operates in an opacity range of 5-10 percent with up to 30 percent allowable.

The company conducted a series of tests beginning in May 1977 to determine particulate emissions and to evaluate the effects of substituting a solid fuel for portions of the natural gas. The solid fuel (refuel) is a mixture of coal and petroleum coke, usually 40 percent coal and 60 percent coke. The results are shown below.

Date	Particulate Emissions, lb/hr		Fuel Used	
	Average	Range	Percent Refuel	Percent Natural Gas
Main stack				
5/14/77	77	52-91	20	80
6/09/77	91	87-96	40	60
6/10/77	61	53-66	0	100
11/16/77	45	25-69	72 (coke)	28
4/20/78	52	48-57	100	0
Average	65			
Clinker cooler stack				
6/08/77	7.4		40	60

From the results it appears that the use of refuel and coke did not have any adverse effect on particulate emissions. The regulation emission limits for this stack are 120 lb/hr particulate and 30 percent opacity. These data are plotted in Figure 29-2.

The following data are from emission inventory reports:

Year	Emissions Rate, lb/hr
1973	22.8
1975	22.8

5.3 Potential for Improved Performance

Electrostatic precipitators, when operating properly, are an effective method of controlling particulates. An industry evaluation indicates that they have operating problems attendant with a great deal of down time. Consistent with this opinion, are the city, county, and state regulatory agencies' records of receipt of over 100 Rule 7 and 8 notifications from portland cement plants that seem to be trying to comply with regulations. The agency is generally satisfied that the plant is making an effort to rectify problems that occur.

There seems to be an economic incentive here to install air pollution control equipment that is more reliable to avoid shutdown time. Assuming that air control equipment shutdown time is five percent for a plant that produces $30 million worth of product per year, that amounts to $1.5 million in lost production. An improved type of precipitator, or more reliable equipment with equivalent performance, could substantially improve air quality and have sufficient economic incentive to justify its purchase.

The plant is located about three miles from the Harris County courthouse in downtown Houston. Having a 200-foot stack makes the facility conspicuous. The company realizes that they need to maintain a consistent effort to conform with regulations.

6.0 Costs

6.1 Capital Costs

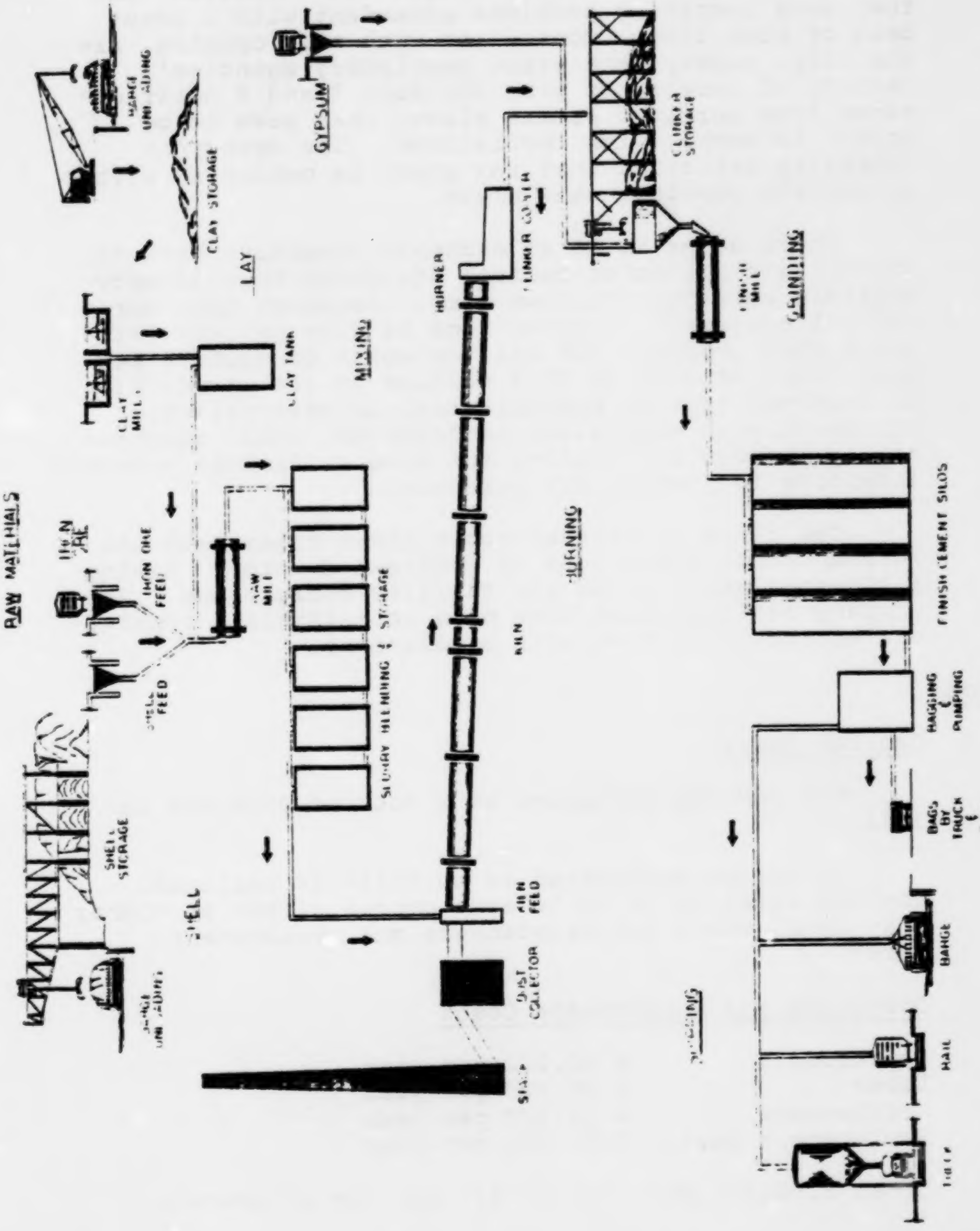
The ESP was installed at a cost of $500,000 in 1962.

It can be considered to be fully depreciated. The low asset value is to some degree offset by higher than usual costs for maintenance and replacement parts.

6.2 Operating and Maintenance Costs

Electricity	$ 80,000 per year
Labor	$ 30,000 per year
Maintenance	$ 50,000 per year
Replacement parts	$100,000 per year

Total $260,000 per year or 87¢ per ton of product.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DUST COLLECTOR
STACK
KILN
BURNING
BURNER
CLINKER COOLER
CLINKER STORAGE
GYPSUM
FINISH MILL
GRINDING
FINISH CEMENT SILOS
BAGGING & PUMPING
BAGS BY TRUCK & RAIL
BARGE
RAIL
TRUCK
SHIPPING

Figure 29-1. Flow chart - Portland cement manufacturing

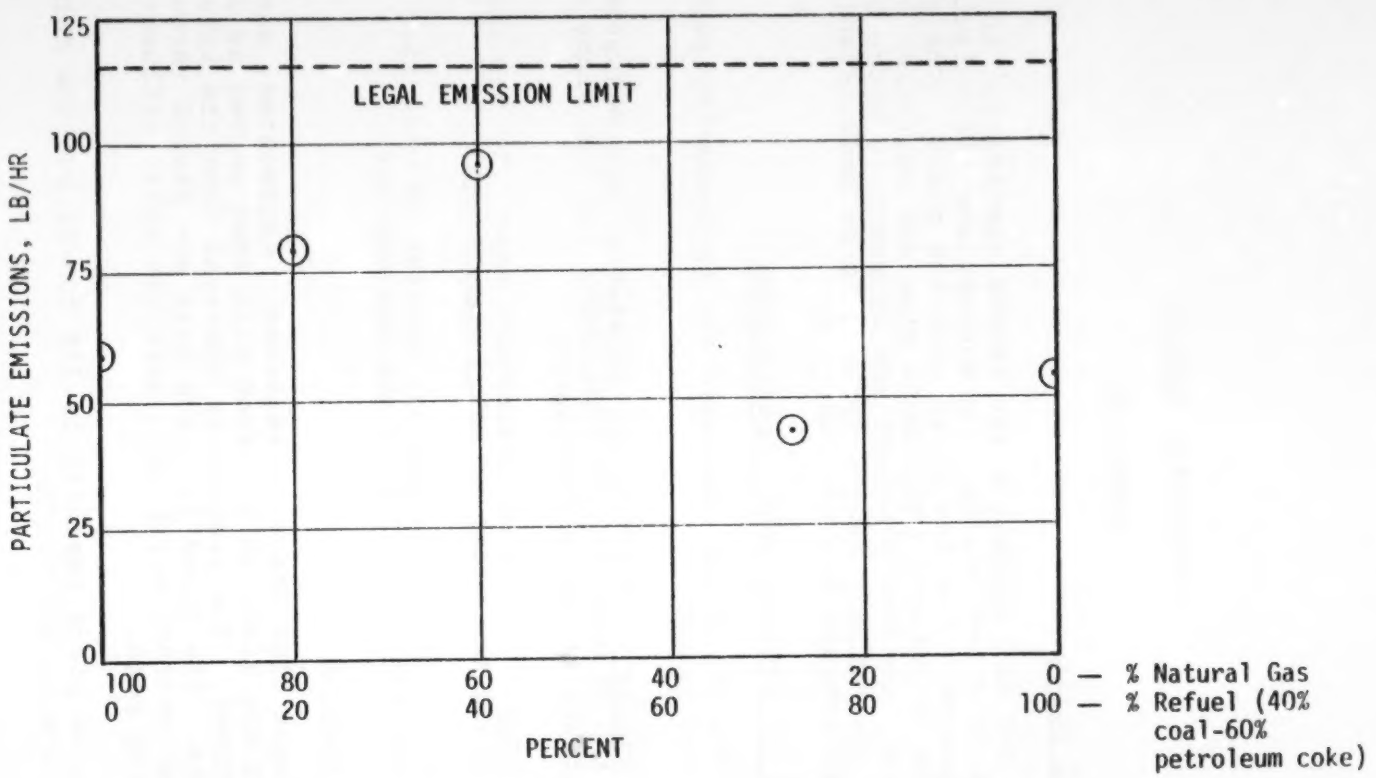

Figure 29-2. Effect of substituting refuel for natural gas on particulate emissions at cement plant.

INSPECTION REPORT

SOURCE 30

1.0 Summary of Visit

This hot mix asphalt plant became operational in 1975. Since this is a new source, the appropriate air pollution control equipment was installed with the plant. The plant seems to be in general compliance with air pollution control regulations. Control problems are inherent to batch operations but the company record appears to be considerably better than average for the industry.

2.0 Chronology of Source/Agency Interaction

1975	The plant was completed and an operating permit was issued.
1976	January. Particulate emissions were measured by the Houston Health Department and the plant was found to be in compliance.
1977	June. An annual inspection report by the city found the plant to be in compliance.
1975-1977	This plant received six notices of violation and was required to pave the parking lot.

3.0 Plant Description

A process flow chart is attached. Aggregates, sand, and asphalt are mixed in a heated kiln that serves as a dryer and mixer. The product is conveyed from the kiln to storage bins. The gases from the kiln are passed through a Boeing water venturi scrubber. Scrubber water effluent goes to a settling pond.

The rated plant capacity is 250 ton/hr but the normal operating rate is 200 ton/hr.

4.0 Air Pollution Control Equipment

The scrubber was installed in 1975 with the plant. The water flow rate is 250 gallons per minute, and the air flow rate is 50,000 actual cubic feet per minute. The rated efficiency is 98 percent. About 20 tons of material are removed from the ponds each week (wet slurry). Based on 50 weeks per year operations and 30 percent solids in the slurry, about 300 tons per year of particulate are collected. This material is sold as a road base.

5.0 Performance Evaluation

5.1 Preventive Maintenance Program

The nozzles are replaced twice per year. At the same time, material build-up on the sides of the kiln is removed. Each scheduled shutdown period requires one or two days. The plant was once down for a week to replace the fan motor.

5.2 Recordkeeping

There are no continous monitoring instruments at this plant. The only available data are measurements which have been made by the city agency.

5.3 Emissions Data

In January 1976, the city health department measured opacity and emission rates. The opacity was zero (maximum allowed 20) and the emission rate was 0.0305 gr/dscf (maximum allowed 0.04).

5.4 Spare Parts Inventory

A full set of 32 nozzles is kept in inventory. These are the only particulate control parts kept on hand.

5.5 Other Comments

This plant appears to make a conscientous effort to comply with air pollution control regulations.

6.0 Cost Data

a. Capital cost: $75,000 (1975)

b. O & M cost: 50,000 (estimated)

The O & M cost was estimated from the following information:

300 hp. fan motor

one-half man year for maintenance

other costs such as recirculating pump motor and repairs, spray nozzles, water costs, etc.

c. Spare Parts Inventory: Not available

A set of 32 nozzles costs $320; nozzles are replaced twice per year.

d. Capital cost of scrubber estimated to be $75,000 (15 percent of total plant capital of $500,000).

e. One week's lost production while the fan motor was being replaced was estimated as a loss of $7,000 to $8,000.

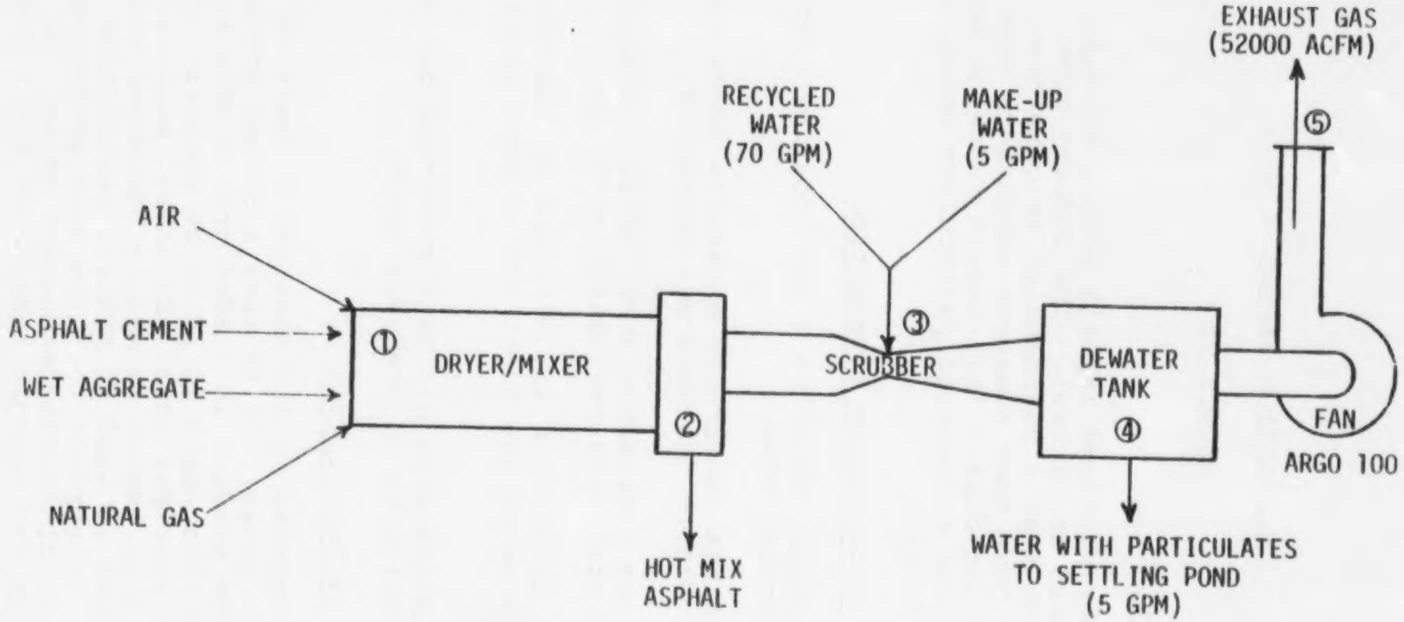
EXHAUST GAS
(52000 ACFM)
RECYCLED
WATER
(70 GPM)
MAKE-UP
WATER
(5 GPM)
⑤
AIR
③
ASPHALT CEMENT
①
DRYER/MIXER
SCRUBBER
DEWATER
TANK
WET AGGREGATE
②
④
FAN
ARGO 100
NATURAL GAS
HOT MIX
ASPHALT
WATER WITH PARTICULATES
TO SETTLING POND
(5 GPM)

Figure 30-1. Process flow diagram - Asphalt Plant.

INSPECTION REPORT

SOURCE 31

1.0 Summary of Visit

This company produces asphalt paving material by mixing hot asphalt and gravel. The company moved in 1974 to a new location near a residential neighborhood. Since the move, there have been numerous complaints concerning excessive odors and dust. This report concerns the fabric filter that is used to control particulate emissions from the gravel drying kiln.

2.0 Chronology of Source/Agency Interaction

1974	The company moved to a new location near a residential area.
1974	Complaints concerning excessive odors and dust began before the move was completed.
1975	Frequent complaints about odors and dust were registered with regulatory agencies.
1975	Court injunction was obtained by the city to reduce odors and dust, and to pave in-plant roads.
1976-1977	Complaints from citizens continued but not as frequently as in previous years.

3.0 Plant and Process Description

Gravel is trucked in and conveyed by belt to a rotary kiln where it is dried. It is then screened and mixed with hot asphalt. The product is loaded onto trucks and taken directly to the site where it is to be applied. Process capacity is 150 tons per hour, and annual production is 150,000 tons. This report is mainly concerned with the fabric filter that is used to control particulate emissions from the kiln. It appears that the odor producing process at this plant has no control equipment on it. No information was given on the asphalt heating or the aggregate mixing equipment.

4.0 Air Pollution Control Equipment

The fabric filter was manufactured by Standard Havens, Inc. There are 480 bags, 12 feet long. The design flow rate is estimated to be 20,000 acfm and the operating efficiency is estimated to be 99 percent.

5.0 Performance Evaluation

5.1 Preventive Maintenance Program

Once every two weeks, the kiln is shut down for eight hours to repair the fabric filter. The bags are inspected for pinholes and replaced when needed. The screw conveyer is a frequent source of operating problems and is inspected and repaired as needed during these scheduled shutdowns.

5.2 Emissions Data

The regulatory requirement is that opacity must be less than 30 percent. The plant does not have an in-house capability of measuring opacity. No records of opacity or particulate emission rates have been kept. No stack tests for particulate emissions have been made.

5.3 Spare Parts

Spare parts kept on hand include:

Item	Number	Total Cost
Spare Set of Bags	480	$8000
Motor	1	$1000
Impeller	1	$ 500
Cages	20	$ 176
Clamps	250	$ 280
Total		$9956

These data were supplied by the manufacturer and in some cases have been modified to conform with costs experienced in similar operations.

6.0 Cost Data

a. Capital cost: $42,000 (1973)

b. O & M cost: Not available

c. Spare parts inventory: $9,956

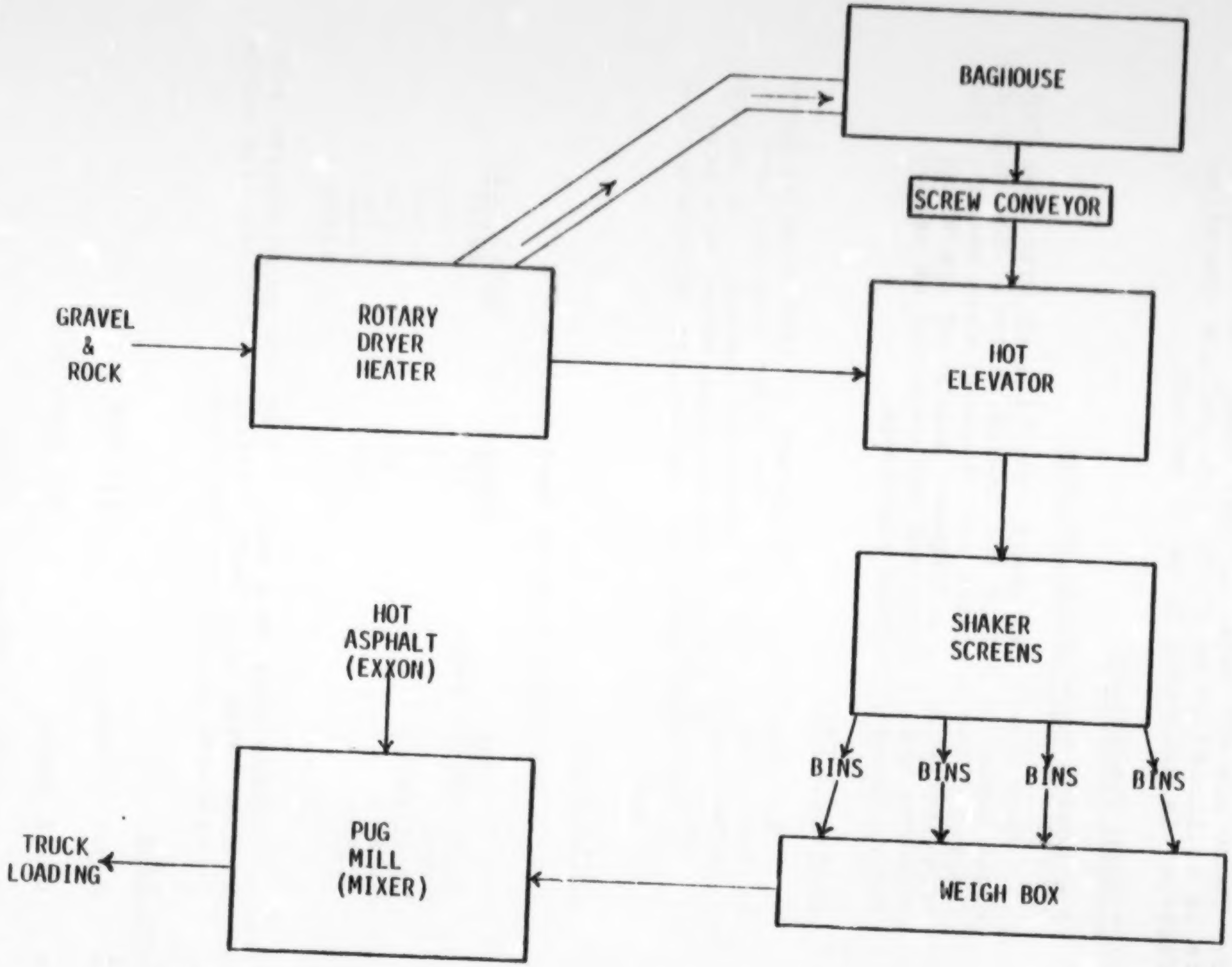
BAGHOUSE
SCREW CONVEYOR
GRAVEL & ROCK
ROTARY DRYER HEATER
HOT ELEVATOR
SHAKER SCREENS
BINS
BINS
BINS
BINS
WEIGH BOX
HOT ASPHALT (EXXON)
PUG MILL (MIXER)
TRUCK LOADING

Figure 31-1. Process flow chart - Asphalt hot mix.

INSPECTION REPORT

Source 32

1.0 Summary of Visit

This facility is an ammonium phosphate fertilizer manufacturing complex. The plant is currently in general compliance with air quality control standards. Much of the air pollution control equipment was installed as the result of notifications of violation and a court order to reduce emissions. The emission source reviewed in this report is a sulfuric acid plant. Elemental sulfur is the primary raw material, and all of the acid produced is consumed in the fertilizer plant.

2.0 Chronology of Source/Agency Interaction

1970-1973	Many instances of excess particulate emissions from the sulfuric acid plant were recorded by the regulatory agencies.
1972	August. The TACB annual inspection report showed eleven of 34 stacks out of compliance with Regulation I, including the sulfuric acid plant stack.
1973	February. Court action was initiated by the TACB.
1973	June. The final court settlement ordered the company to eliminate excess particulate emissions from the sulfuric acid plant by December 31, 1973.
1973	November. A Brink mist eliminator was installed. This brought the source into compliance with Regulation I.
1974-1977	One or two excess opacity violations were recorded by the agencies each year.

3.0 Plant and Process Description

This source is a 1500 ton per day sulfuric acid plant converting elemental sulfur to sulfuric acid by the contact process. Sulfur is burned in air to form SO_2 which is further reacted with atmospheric oxygen in the presence of a V_2O_5 catalyst to produce SO_3. The SO_3 is absorbed in 98-99 percent sulfuric acid and is diluted to desired strength for fertilizer manufacture.

Phosphoric acid is produced for fertilizer manufacture by treating phosphate rock with the sulfuric acid produced in this plant. The design and construction of sulfuric acid plants is fairly standardized, and this plant is typical.

4.0 Air Pollution Control Equipment Evaluation

No information was given on the ammonia scrubber or the Brink mist eliminator. From the emission inventory files it is obvious that the ammonia scrubber was inadequate to control particulate emissions in the early 1970's. The mist eliminator installation was necessary to obey a court order to control excess particulate emissions.

It is well known that the Brink mist eliminator has a removal efficiency of 95 percent or higher for sulfuric acid mist when properly sized for the exhaust gas flow rate. Judging from what the company engineer said and from the emission inventory files this mist eliminator has kept the source within compliance except for just a few exceptions.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

The company engineer would not supply any information concerning inspection and maintenance procedures. It is generally recognized that the Brink mist eliminator is a very reliable piece of equipment.

5.2 Emissions Data

The only available emission data are from emission inventory reports submitted to the TACB between 1970 and 1975.

The following data were taken from the emission inventory files.

Particulate Emissions, lb/hr

Year	Actual	Allowable
1970	11	52
1971	5	52
1972	46	52
1973	87	52
1974	no data	
1975	5	52

These data are shown in Figure 32-1.

6.0 Cost Data

Operating and maintenance costs were not available. Data submitted by the company to the Bureau of the Census were used to estimate costs. These data are for the entire manufacturing complex rather than for individual sources.

a. Capital Costs

In 1973, $1,856,000 was spent for the control of particulates, including the Brink mist eliminator.

b. Operating Costs

Table 32-1 shows air pollution control operating costs for the entire fertilizer plant. Costs are allocated for depreciation, labor, equipment leasing, and materials, supplies, etc.

c. Spare Parts

All parts are catalogued. No distinction is made between parts used for production equipment and for pollution control equipment. Doing this would be difficult because many items such as pumps are used for production processes as well as for pollution control. Effort is made to standardize equipment.

Parts are charged out from inventory on a current-cost basis rather than on the basis of actual purchase costs.

Table 32-1: Facility Pollution Control Cost Summary

Pollution Control	1972	1973	1974	1975	1976
Operating Cost, ($ x 10^6)	Not given	1197	1808	2573	2610
Percent for control of air pollution	77	43	52	36	26
Air pollution control cost ($ x 10^6)	--	515	940	926	940
Percent allocated to depreciation	34	54	53	21	20
Percent allocated to labor	39	14	15	18	3
Percent allocated to equipment leasing	3	2	2	--	--
Percent allocated to materials, supplies, etc.	24	30	30	61	77
Cost per ton of product ($)	--	7	11	15	15

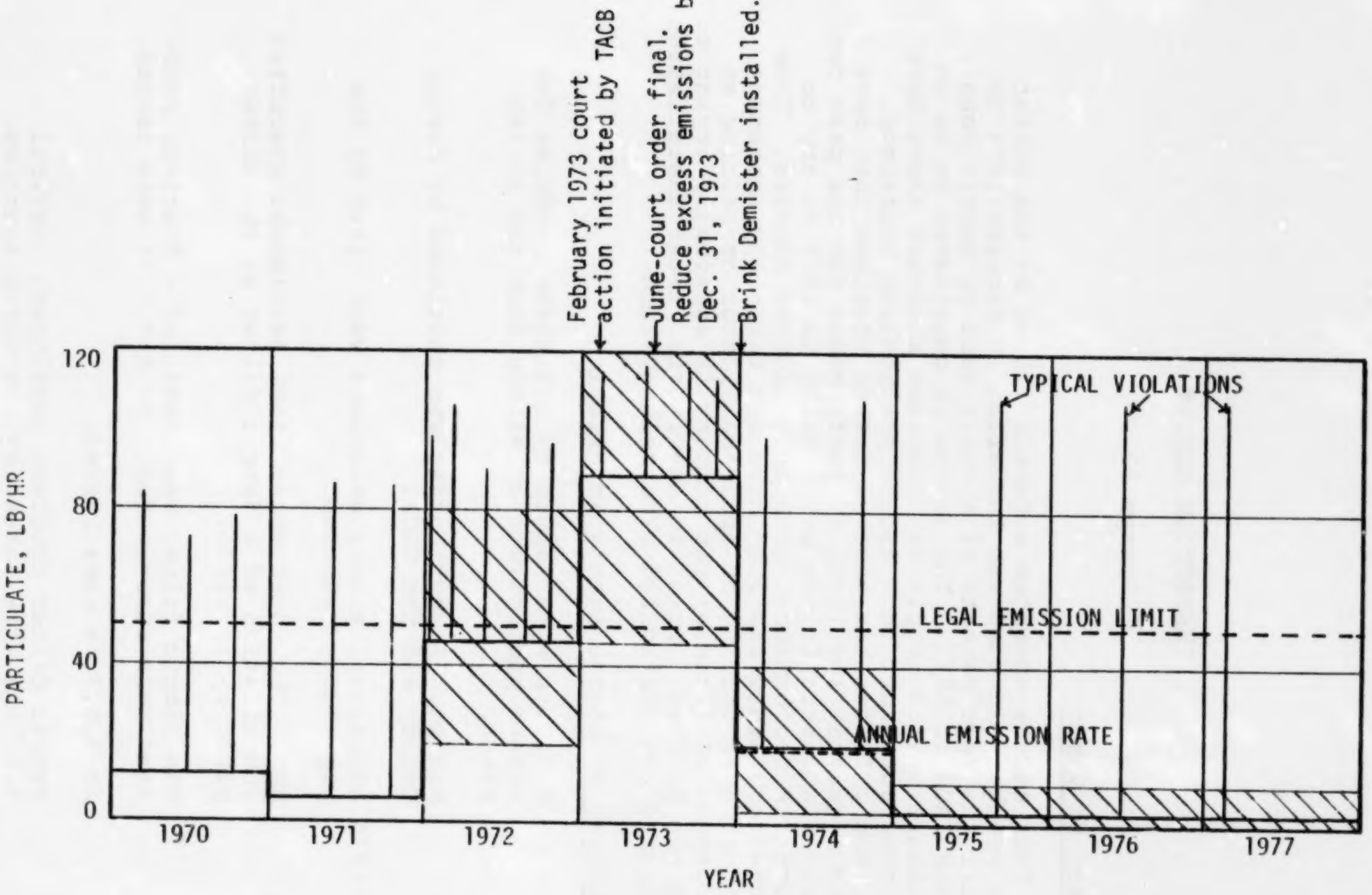

Figure 32-1. Demister at sulfuric acid plant. Eight year particulate emission profile.

INSPECTION REPORT

Source 33

1.0 Summary of Visit

This source operates a fabric filter at the sinter plant breaker end that was installed in January 1974 to fulfill the requirements of a court suit by Harris County and the TACB in 1973. The source is considered to be in compliance by the regulatory agencies although there have been numerous short term excess particulate emissions. This fabric filter has several design problems that have caused a general low level of performance for the past two years. The fabric filter was rebuilt in 1977 to try to improve its performance, with only limited success. Thus far the regulatory agencies have not taken any abatement action such as sending an abatement letter or calling an enforcement conference; the company is apparently trying to solve the problem. Prior to the fabric filter installation, the source was controlled by a multicyclone.

2.0 Chronology of Source/Agency Interaction

1970	N.O.V.'s were issued by all three agencies for excess particulate emissions from the sinter plant.
1970	August. A court order was initiated by Harris County and the TACB.
1970-1973	Additional excess emissions were cited by the regulatory agencies.
1973	May. The court order final settlement specified installation of a fabric filter at the sinter plant by 10/31/73.
1974	The fabric filter was installed - Start-up problems were encountered. No N.O.V.'s were issued.
1975	No N.O.V.'s were issued.
1976	Fabric filter problems developed. Several N.O.V.'s were issued by the three agencies.

1977 Company conducted studies to determine how to fix the fabric filter. Unit is to be rebuilt in 1978 or 1979. Five N.O.V.'s were issued by the agencies.

2.1 Compliance History

This company installed control equipment on the major pollutant emitting processes when they were constructed in the 1950's and 1960's. When this sinter plant was built in 1957 a multicyclone was installed to collect product and to control air pollution from the breaker hood. Fugitive dust was allowed to escape to the atmosphere legally at that time, but in the late 1960's and 1970 many N.O.V.'s were issued for these fugitive emissions. In August 1970 Harris County and the state brought legal action to force the company to abate the excess emissions. A final settlement was reached in May 1973 stating dates by which specific emissions should be reduced and setting a fine which the company had to pay. For this sinter plant the company was required to install a fabric filter and better hoods by October 31, 1973. The equipment was installed by January 1974, and operated within control limits during 1974 and 1975. By 1976 severe problems had developed with the equipment and at least five N.O.V.'s were issued in 1977. No abatement action was taken by the regulatory agency because the company was conducting tests to determine how to rebuild the equipment to restore it to good operation. The latest regulatory annual inspection report stated that the sinter plant breaker end was in compliance under normal operation.

3.0 Plant and Process Description

This facility is a large integrated steel mill making iron from iron ore by the blast furnace method, steel by the electric furnace process, and finished steel products in rolling mills, pipe mills, and finished structural mills. The facility also operates a coke plant, sinter plant, and lime kiln.

The process reviewed is the sintering plant where more than 1000 ton/day of various iron-bearing fines and wastes are recycled.

Sintering is a process that bonds iron-bearing fines and wastes from various sources into an agglomerate of sufficient size and composition to be charged into a blast furnace. Materials that are commonly used in the sintering operation are coke breeze, limestone, blast furnace flue dust, filter cake from the blast furnace gas washing system, hot mill scale, electric furnace slag fines, and other fine metal-bearing materials.

Limestone, coke breeze, and material from the ore bed are stored separately in large bins and proportioned onto a moving belt by table feeders. The composition averages 82 percent ore bed, 15 percent limestone, and 3 percent coke breeze. The mixture is conveyed into a balling drum where water is added to promote balling and to provide proper moisture content. From the balling drum the mix is conveyed to a Syntron slotted feeder from which it is distributed onto the sinter strand. It forms a 10-inch layer on top of the hearth layer which is composed of excess and odd size sintered material. The sinter strand is six feet wide and 90 feet long from ignition hood to discharge end. The 12-in. thick bed of material is ignited from above by a natural gas fired igniter directed at the surface of the mix. A draft is pulled through the bed from below the strand via 14 wind boxes. This causes the mixture to burn from the surface downward as the strand moves along at a rate of five or six feet per minute. Draft is provided by a large fan that exhausts the gases to a high energy steam injection wet scrubber.

When the sintered material reaches the end of the machine, it falls into a crusher that breaks up the large pieces. Exhaust air from the crusher is drawn through the fabric filter. The sinter passes onto a straight line cooler via a screening station. The cooled sinter is conveyed to a screening area and sized. Plus 3/4 in. and any 3/4 in. by 3/8 in. material not used for hearth layer is stockpiled or conveyed to the blast furnace. Material that is less than 1/4 in. is recycled into the sinter mix.

This sintered material constitutes more than 25 percent of the feed material for the blast furnace. This important recycling process saves many dollars in feed material and eliminates a significant solid waste problem.

4.0 Air Pollution Control Equipment

A fabric filter manufactured by the Western Precipitation Division of Joy Manufacturing Co. was installed in January 1974. The pulse jet unit is sized to filter 112,000 acfm of air with a dust loading of 4.6 gr/scf. Design outlet dust concentration is 0.06 gr/scf. Thus the filter is about 98.7 percent efficent. Precise alignment of the pulse venturi, required for proper bag cleaning, has not always been achieved. Maintenance problems and several bag failures have been attributed to improper bag cleaning.

Bag failures have allowed dust to pass through the unit and have caused at least one fan failure due to erosion of the fan blades.

The clean air plenum was rebuilt in 1977 to install stationary pulse jet venturis. This change was an improvement but was not entirely satisfactory. Additional tests have been conducted to determine how to rebuild the fabric filter for better operation. The dust collected in the fabric filter is recycled to the sinter plant.

The expected remaining life of this equipment is about three years.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

There were some basic design problems with this equipment that made operating and maintenance very difficult. The original movable venturi assembly was a bad design feature because precise alignment was required for proper cleaning. Improper cleaning of the bags caused the bags to plug, increasing the air velocity through the other bags. This caused bag erosion and fabric blinding. Dust penetration from bag failure resulted in erosion of the fan blades and ultimate fan failure. Other maintenance problems were the inaccessibility of the bags; the filter top had to be removed to obtain access to the bags for replacement.

Major repairs are made during the sinter plant scheduled shutdowns of two days per week. When the fabric filter is completely out of service the sinter plant must be shut down.

5.2 Emissions Data

1970 No stack tests were made on the multicyclone.
Tests on inlet to multicyclone - 350 lb/hr

Assuming 70 percent efficiency, the outlet from the multicyclone is 105 lb/hr. AP-42 lists an emission rate of 2.0 lb/ton of product. Since the process converts 1200 ton/day, estimated emissions would be 1200/24 x 2.0 = 100 lb/hr. The 1970-1973 legal emission limit is not known.

1974 March. Compliance test conducted by the TACB stack testing team.

Actual emissions: 37 lb/hr
Allowable emissions: 65 lb/hr

No other data were available for the fabric filter. It is known that broken bags and the unusual maintenance problems caused the average particulate emissions to be somewhat higher in 1976 and 1977 than in 1974 and 1975.

The above data and estimates are shown in Figure 33-1.

5.3 Spare Parts Inventory

Fan motor and bearings, bags, and miscellaneous hardware. The company engineer estimated the cost as $15,000.

6.0 Cost Data

Capital cost:	$600,000 (1973 dollars)
Operating cost:	not available
Spare parts:	$15,000

	TOTAL STEEL MILL		ENVIRONMENTAL CONTROL
	Capital	Operating	Capital
1970	$ 57,774,700	$ 108,397,000	$ 218,800
1971	32,474,900	106,511,000	4,400,500
1972	10,456,900	108,641,000	3,486,500
1973	3,937,300	173,467,000	860,900
1974	5,503,200	224,002,000	1,119,100
1975	20,750,800	246,622,000	14,619,800
1976	22,816,000	169,502,000	18,322,900
1977	7,860,500	247,880,000	3,980,100
Total	$161,574,300	$1,385,022,000	$47,008,600

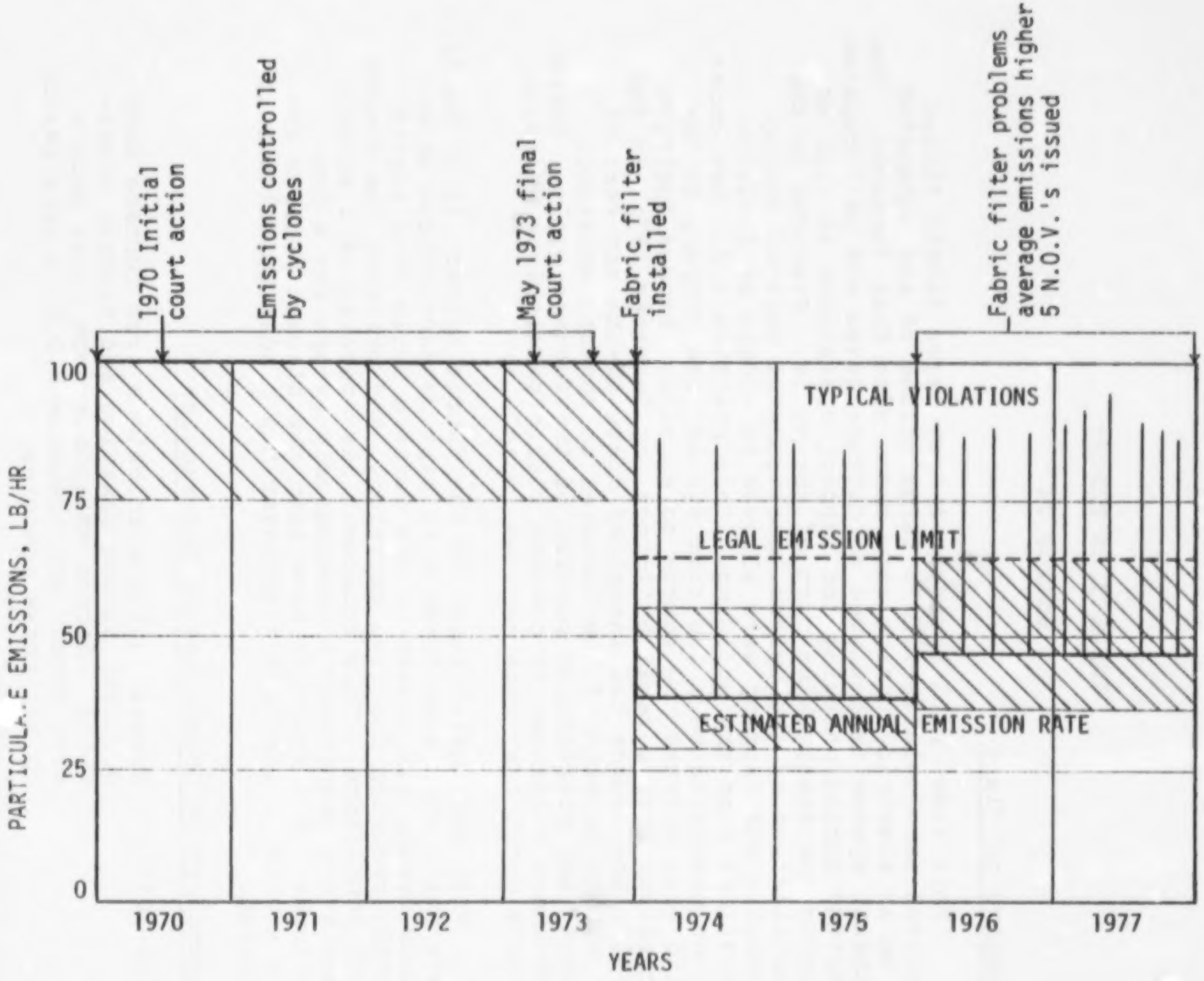

Figure 33-1. Sinter plant breaker. Eight year emissions profile

INSPECTION REPORT

Source 34

1.0 Summary of Visit

This steel mill operates a very large fabric filter to control particulates from a large volume of air exhausted from an electric furnace shop containing four furnaces. The exhaust system is designed to capture gases and particulates emitted during charging and tapping operations as well as during the steelmaking part of the cycle. Previous to the installation of the system, particulates emitted during charging and tapping were allowed to escape as fugitive emissions from the building. This practice and other emissions precipitated a law suit against the company in May 1973 that ordered the source to eliminate excess fugitive emissions from several buildings, by December 1975. In the 1960's the source had installed state-of-the-art venturi scrubbers on each of the furnaces to control emissions during the steelmaking portion of the furnace cycle. These scrubbers continued to operate within particulate emission limits until they were retired in 1976.

With the installation of the fabric filter, large hoods were built over each furnace to capture particulate emissions during all phases of the furnace cycle thus significantly reducing fugitive emissions, and bringing the source into compliance. This equipment has operated well within regulatory requirements continuously except for a few failures. Fan failures have been the biggest problem and the source is installing stronger fan blades to solve this problem.

2.0 Chronology of Source/Agency Interaction

1968-1970	Excess fugitive emissions from furnace shop occurred during charging and tapping operations. Excess emissions from other points were noted, and numerous N.O.V.'s were issued by the three agencies.
1970-August	A court order by Harris County and TACB directed the company to eliminate a number of specified excess emissions.

1970-1973	Numerous instances of excess emissions were recorded by the three agencies.
1973-May	A court order specified the elimination of all excess emissions at the electric furnace shop by December 1975 and fined the company.
1973-1975	Several instances of excess emissions were recorded by agencies, but no N.O.V.'s were issued.
1976-February	The fabric filter installation was completed.
1976-1977	Visible emissions from the fabric filter and the furnace shop were eliminated. Excess emissions were recorded by the city agency on occasions when the fabric filter was inoperable. No N.O.V.'s were issued.

This company installed control equipment on all the major pollutant-emitting processes when those processes were constructed in the 1950's and 1960's. However, because of the size of the steel mill, significant emissions to the atmosphere result when associated pollution control devices fail to operate properly. Furthermore, before the 1970's there were no regulations regarding fugitive emissions, and therefore such emissions were not controlled at this plant. In the early 1970's the state, city, and county agencies began to regulate fugitive emissions, and many N.O.V.'s were issued at this plant. Eventually, legal actions brought against the source by the county and state resulted in a compliance order whereby the company was to correct all its emission problems according to a specified schedule. By the terms of a court order of May 1973, the company was required to install a fabric filter on the electric furnace shop to control emissions by December 31, 1975. The fabric filter installation was completed in February 1976 after the court allowed a two month time extension for delays in delivery of materials for the experimental hoods. This equipment has operated well within regulatory limits except for short excursions when portions of the equipment have been down for emergency repairs. The regulatory agencies have noted several instances of excess emissions during these outages but have not taken any abatement action. Agency personnel have indicated that this pollution control system has done an excellent job of controlling emissions. When a portion of the unit is out of service, the charging rate to the furnaces is decreased or stopped to keep excess emissions to a minimum.

3.0 Plant and Process Description

This facility is a large integrated steel mill using a blast furnace to make iron and electric furnaces to make steel. One blast furnace produces molten iron for four 175-ton electric furnaces and mold foundry. Total capacity is 3900 tons per day. The furnaces operate on a three to four-hour cycle. Six or seven heats can be made in each furnace per day, but only two furnaces can be in a charging or tapping mode at the same time because of air volume limitations. Extra hoods and shrouds were added in 1975 and 1976 to pull more air and capture more fugitive dust during the charging and tapping operations. This fugitive dust violated TACB Regulation 131.03.03.003. The entire electric furnace shop is considered as one process unit since the exhaust air from the entire shop is directed through the single fabric filter. Although the maximum steel production rate is 3900 ton/day, normal production is somewhat less ranging from 2000 to 3500 ton/day depending on steel demand and the operating condition of the fabric filter. Usually when a compartment of the unit is down for repairs, the production rate can be decreased temporarily, then made up later without losing any overall production. Larger amounts of exhaust air are required during the charging and tapping portions of the furnace heat cycle when the furnace is open. The two hoods are designed to capture emissions from a particular portion of the cycle, either charging or tapping. Air flow is controlled by dampers. One man is required full time to keep the dampers in proper position throughout the shop.

4.0 Air Pollution Control Equipment

This fabric filter cleans the exhaust air from the entire electric furnace shop. The unit, manufactured by the Fuller Company, contains 6912 bags 35 feet long in three sections that are each divided into eight compartments. Air-to-cloth ratio is 2.9 to 1; total cloth area is 752,095 square feet. Exhaust air is supplied by five fans in parallel each powered by a 2500 hp motor. Maximum air flow is 2.1 million acfm. One or two fans may be shut down while the system remains in operation. When one fan is down only one furnace at a time may be in the charging or tapping mode; if two fans are down one or more furnaces must be shut down. Bags are cleaned by reverse air. The collected dust falls into a hopper from which it is pneumatically conveyed to a central storage bin. The dust is then pelletized for efficient disposal in a landfill. This material has little value to the steel industry because it contains unacceptable quantities of lead and zinc.

Cleaned exhaust air is vented from the top of each section of the fabric filter. There are no visible emissions from the fabric filter, nor from the furnace shop in normal operation. There are no continuous monitors on the equipment except for a temperature monitor to protect the bags. Continuous opacity monitors are not required. The fans are located on the dirty air side of the filter; this has caused considerable erosion of the fan blades. The expected remaining life of the fabric filter is 20 years. Prior to March 1976 venturi scrubbers were used to control emissions from the four electric furnaces, one venturi for each furnace. These were installed when the furnaces were built in the 1960's. However, the scrubbers were inadequate to control fugitive emissions during charging and tapping operations. Consequently the fabric filter was installed to control the significant fugitive emissions during these operations. The venturi scrubbers operated at about 90 percent efficiency and complied with TACB particulate and opacity regulations.

5.0 Performance Evaluation

5.1 Preventive Maintenance and Repairs

We were unable to obtain specific information regarding maintenance and inspection procedures except that fabric filter components were maintained in accordance with manufacturer's recommendations. The unit was equipped with numerous instruments and indicators in an air conditioned control room manned by two operators per shift. The following parameters were monitored in the control room: pressure drop across the bags in each compartment, inlet air temperature, and electrical current draw for each fan. Numerous indicator lights show cleaning cycle sequence and the status of motors, dampers, etc.

The most serious problem with this unit has been failure of the fans. The fans are installed upstream of the fabric filter and are subject to hot, dirty conditions. The fans can only be inspected when the entire furnance shop is down, approximately once per year, or when the fabric filter breaks down. The fans have experienced severe abrasion. One fan failed from blade abrasion only three months after it had been inspected.

Typical fan life has been less than one year, whereas the fans had been designed with an anticipated life of four years. The company would consider locating these fans on the clean air side of the unit, if a new unit were being installed. At the present time fanwheels are being rebuilt using heavier, reinforced material.

Parts of the system were out of service for 17 days in 1976 and 9 days in 1977. Breakdown problems included (1) reverse air fan breakdown, (2) hopper valve failures, (3) pneumatic conveyor system, and (4) reverse air damper mechanism failures. Each of these problems has contributed to one or more partial outages on the fabric filter. The reverse air fan failure caused a complete shutdown of the fabric filter. After that a standby reverse air fan was installed.

The company devotes considerable effort to the maintenance of this unit, since a failure of the fabric filter can force the shutdown of the entire furnace shop. Maintenance costs are given in Section 6.

5.2 Instrumentation

Major instrumentation for this system includes a temperature controller at the inlet to the fabric filter and manometers to show the pressure drop across the bags in each compartment. The temperature controller protects the bags by opening dampers to bleed in dilution air when a high inlet temperature is sensed. The manometers are used to indicate the condition of the bags, e.g., whether they are being cleaned properly.

Since there are no visible emissions from this fabric filter under normal operation a continuous opacity monitor is not required. Instrumentation for operating parameters on the system is located in the control room but fan and motor paramaters are recorded in the substation. This enables the operators to observe operating conditions continually. Two operators are assigned to this system on each shift.

5.3 Emissions Data

July 1973-Stack tests were conducted by the TACB stack testing team with the following results:

No. of Venturi Scrubbers	4
No. of tests made	9
Average emission rate	21.5 lb/hr
Range of tests	12 to 36 lb/hr
Allowable emission rate	55 lb/hr (TACB Reg.I)

The following production figures were supplied by the company pollution control engineer along with emission factors that he considered the most accurate from all the published emission factors.

Year	Production ton/yr	Particulate Emissions* lb/hr
1970	956,695	239
1971	763,004	191
1972	935,231	234
1973	1,226,404	307
1974	1,186,529	297
1975	1,026,021	257
1976	691,660	55**
1977	1,017,211	81**

*Based on 2.1 lb particulate/ton of steel (emission factor).

**After the fabric filter was installed, the company estimated 0.69 lb particulate/ton of steel.

These data are plotted in Figure 34-1. The total annual emission rate includes stack and fugitive emissions. During the period 1970 to 1975, the stack emissions were lower than the legal stack emission limit, when tested and according to opacity readings, but the fugitive emissions caused the total emissions to be higher than the legal emission limit, especially in short excursions. The legal emission limit was higher after March 1976 because the exhaust air flow rate to the fabric filter was large and particulate emission limits are proportional to the exhaust air flow rate. Thus emission reductions were coincident with an increase in allowable emissions.

The following data were found in the 1975 emission inventory files at the TACB office for this source as typical emission rates.

Furnace No.	Stack emission rate, lb/hr	Allowable emission rate, lb/hr	Air Volume acfm
6	24.2	59.4	97,400
7	16.2	46.3	106,600
8	17.6	47.4	106,900
9	27.9	56.6	90,700
Total	85.9	209.7	

Prior to 1976- Maximum total emission rates.

The total emission rate is the stack emission plus the fugitive emissions. The company engineer estimated the total emissions using emission factors which include fugitive emissions.

Total emission rate factor	2.16 lb/ton of steel
Maximum production rate	162.5 ton/hr
Total emission rate (max. prod.)	341 lb/hr
Total emission rate (normal prod.)	288 lb/hr
Venturi emission rate (normal prod.)	86 lb/hr
Fugitive emission rate (normal prod.)	202 lb/hr

After March 1976

No stack tests have been conducted on the fabric filter. The following data estimated by the company engineer includes fugitive and stack emissions.

Estimated emission rate	0.69 lb/ton of steel*
Maximum production rate	162.5 ton/hr
Maximum emission rate	112 lb/hr
Allowable emission rate	399 lb/hr (Reg. I)
Current production rate	133.3 ton/hr
Current avg. emission rate	92 lb/hr

*Based on emission factors and hood capture rate.

5.4 Spare Parts Inventory

Total cost of identifiable items is $350,000. Other spare parts are in general spares for the facility. The spare parts inventory includes:

Reverse air fan (installed)
Main fan housing and motor
Compressor
Parts for the pneumatic conveyor system
Bags and clamps
Recorders for the control room

6.0 Cost Data

a. Capital cost - fabric filter

Equipment	$ 7 million
Engineering and installation	8 million
Total	$15 million

b. Operating and maintenance cost - 1977: $1.86 million

c. Spare parts inventory: $350,000

d. Total plant capital and operating expenditures by year:

	TOTAL PLANT		
	Capital	Operating	Environmental Control Capital Expenditures
1970	$ 57,774,700	$ 108,397,000	$ 218,800
1971	32,474,900	106,511,000	4,400,500
1972	10,456,900	108,641,000	3,486,500
1973	3,937,300	173,467,000	860,900
1974	5,503,200	224,002,000	1,119,100
1975	20,750,800	246,622,000	14,619,800
1976	22,816,000	169,502,000	18,322,900
1977	7,860,500	247,880,000	3,980,100
Total	$161,574,300	$1,385,022,000	$47,008,600

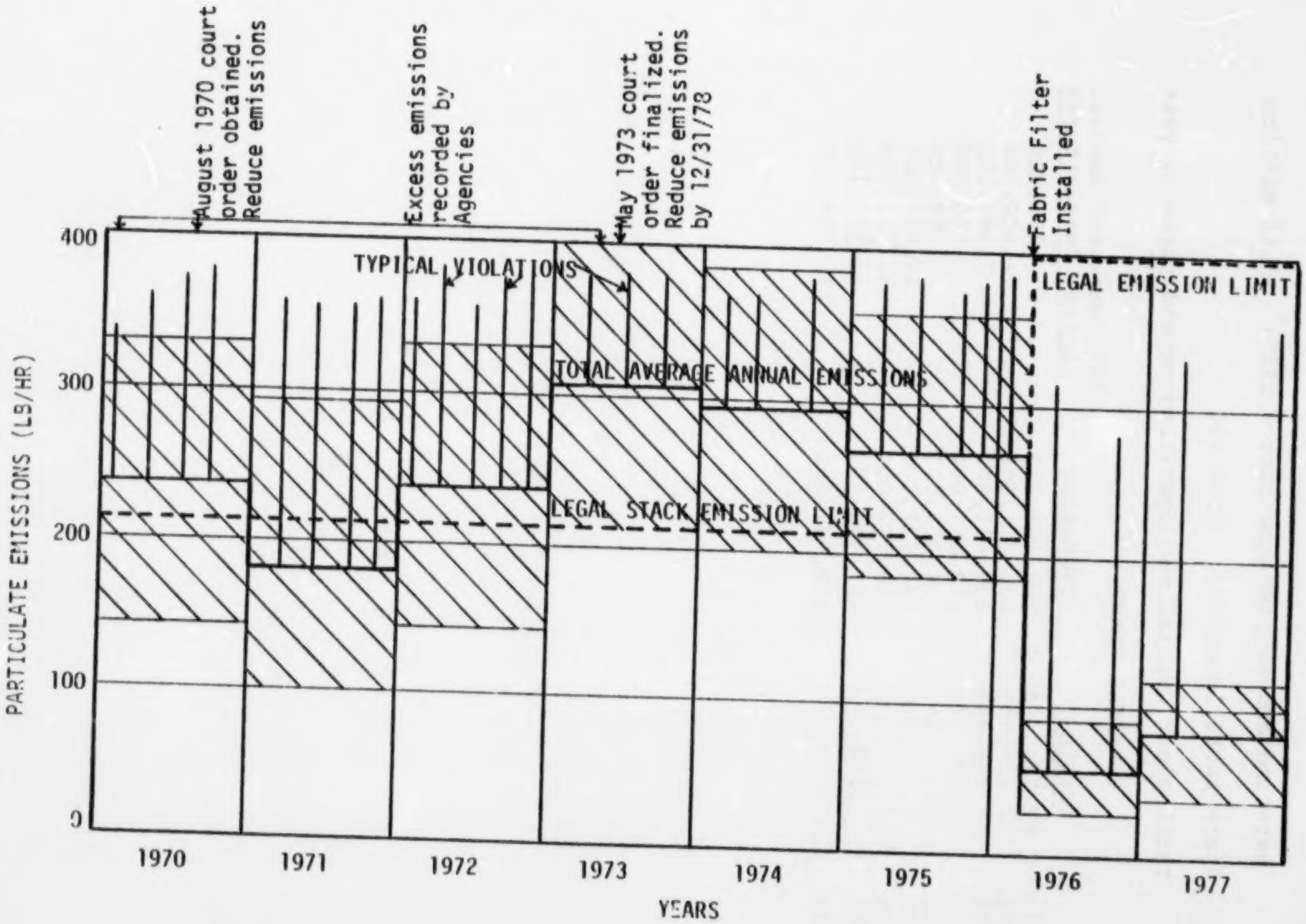

Figure 34-1. Electric furnace shop - Eight year emission profile.

INSPECTION REPORT

SOURCE 35

1.0 Summary of Visit

This plant produces butadiene by the dehydrogenation of n-butene. This process produces waste hydrocarbon off-gases that must be removed from the process. Prior to 1975 these waste gases were released to the atmosphere. Although the company was in general compliance with the existing regulations, it had received numerous odor complaints. After new regulations for hydrocarbon control were passed and with a desire to eliminate excessive odors the company installed a waste gas incinerator in 1977. This incinerator has allowed the company to operate within regulation limits since that time except for a few brief intervals.

2.0 Chronology of Source/Agency Interaction

1973-1975	The three regulatory agencies investigated many odor complaints, and a number of N.O.V.'s were issued to the company.
1975	The company agreed to purchase an incinerator system.
1976	The incinerator system was designed and installed.
1977	The incinerator system was started-up in January. The unit has allowed the company to operate within regulations except for a few brief outages for modifications and emergency repairs.

3.0 Plant and Process Description

This plant produces butene, butadiene, and maleic anhydride from basic hydrocarbons such as butane. Butane is dehydrogenated using air and steam to form n-butene which is processed to make butadiene. This process yields unwanted gaseous hydrocarbons that must be removed. These gases are stripped from the process and introduced to a natural gas fed waste gas incinerator.

4.0 Air Pollution Control Equipment

This incinerator is designed to treat 235,000 lb/hr of waste gas containing about 0.4 percent hydrocarbons. The waste gases enter the incinerator between seven vertical cone duct burner assemblies to be incinerated at 1300°F with a retention time of 0.6 second. The incinerator, designed by the Henry Vogt Machine Company, utilizes flue gas recirculation, which, allows it to generate a constant 100,000 lb/hr of 750 lb steam, under variable waste gas flow conditions.

The system is at least 93 percent efficient in the destruction of hydrocarbons. The incinerator consumes about 130,000 scfh of natural gas which supplies 84 percent of the firing energy, the other 16 percent being supplied by the hydrocarbon waste gases.

The design and operating capacity of this equipment appear to be appropriate for the plant and the process.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

There is no scheduled maintenance for this equipment. The on-stream factor has been about 98 percent, and the incinerator has required very little maintenance. It has been shut down four times to make modifications recommended by the manufacturer to improve efficiency, and it has been shut down three times for minor repairs such as repairs of steam leaks and the recirculation fan.

5.2 Recordkeeping

The temperature and oxygen content of the incinerator flue gas is monitored by continuous monitors. These records have been maintained.

5.3 Emissions Data

The following data were taken from the emission inventory forms and data supplied by the company.

	Hydrocarbon Emissions		Allowable
Year	ton/yr	lb/hr	Emissions, lb/hr
1970	3600	857	NA
1971	1954	465	NA
1972	1954	465	NA
1973	2200	524	NA
1974	2200	524	500

1975	931	222	500
1976	930	222	500
1977	543	130	500

These data are shown in Figure 35-1 as annual emission rates. The estimated accuracy is $^{+100\%}_{-50\%}$.

6.0 Cost Data

a.	Capital cost:	$2.5 million (1976)
b.	O & M annual cost:	$1,477,000
	Labor:	$ 50,000
	Parts and materials:	$ 40,000
	Gas, water & electricity:	1,387,000
	Total	$1,477,000

This is partially offset by a 100,000 pound per hour steam credit calculated to be $910,000 at $1.50/million BTU.

c. Spare parts inventory: $100,000

Spare parts include motors, tubes, and control equipment.

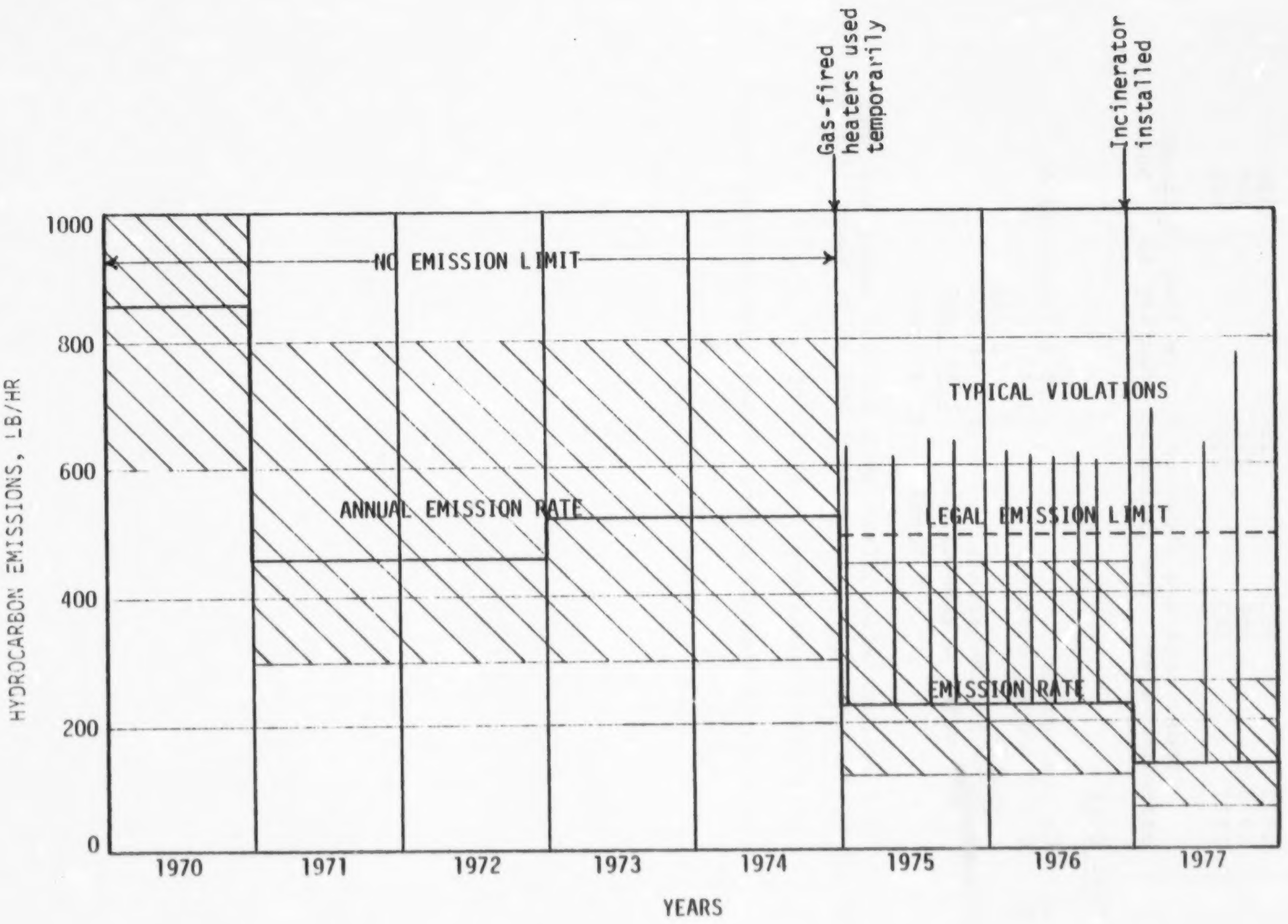

Figure 35-1. Waste gas incinerator - Eight year emission profile.

INSPECTION REPORT

Source 36

1.0 Summary of Visit

This company operates 19 fabric filters at this grain handling and storage facility to control dust emissions from all of the common grain handling operations. There were no visible emissions at the time of the visit. Truck and rail car unloading operations that are usually very dusty are controlled by pulling exhaust air from hoods above the cars and from vents near the grain bins and passing the air through fabric filters.

The source has a good record of complying with regulations, adding 10 fabric filters in 1970 and 1971 at the request of the TACB inspectors. Additional units were added in 1975, 1976, 1977, and 1978. The entire facility is considered in this report as one source, since the same type grain dust is produced throughout the plant in closely related grain handling operations. Approximately 120,000 pounds of dust are hauled away by truck each week. This dust is sold to cattle feeders since it has a comparatively high protein content.

2.0 Chronology of Source/Agency Interaction

1968-1970	The source was operating cyclones on all grain handling operations.
1970	TACB inspectors requested that the source eliminate or reduce excess dust emissions.
1970-1971	The source replaced 10 cyclones with fabric filters. This brought the source into compliance.
1974	TACB inspectors requested additional control devices on facilities with excessive dust emissions.
1975	Three fabric filters were installed.
1976-1977	Five fabric filters were installed on new storage facilities.

This company has a policy of voluntary compliance with all air pollution control regulations. Each time the inspector pointed out where they were in violation of the regulations, they proceeded to install another filter along with a hood and shrouds if needed. The filters have operated with few breakdowns over the years such that the company has been in continuing compliance. The rationale for installation of the cyclones initially was to recover grain dust. The rationale for installation of additional fabric filters was to comply with regulations.

3.0 Plant Description

This company operates a large grain storage and handling facility on the Houston ship channel. They have unloading facilities to receive grain by truck, train or barge, and they have ship loading facilities. The facility, a transshipping point for export sales, has storage capacity for about 8.5 million bushels of grain. The facility currently handles upwards of 150 million bushels per year,and is one of the nation's largest exporters of hard red winter wheat.

The many sources of dust at this plant include unloading facilities, elevating legs, distributors, bin vents, weighing operations, and ship loading facilities. Cyclones were installed at strategic points when the plant was built in 1965. These cyclones did not perform satisfactorily, allowing all of the fines to pass to the atmosphere. Some operations had no control equipment at all. In 1970 the regulations became more stringent. In response to a request by the agency to comply with the new standards, the company began to replace the cyclones with fabric filters. In 1970 and 1971 a total of 10 fabric filters was installed. The company also built shrouds and hoods on all unloading facilities. The entire facility is regarded in this study as one process, and allowable process emissions are based on the combined flows through all of the fabric filters.

4.0 Air Pollution Control Equipment

The Company uses HSC Jet Modular square welded fabric filters manufactured by the George A. Rolfes Co. in Boone, Iowa. These filters utilize 100 psig compressed air in a jet pulse to effect dust removal from the bags. They range in size from 36 bags to 240 bags (8-ft bags) and capacities range from 5000 cfm to 30,000 cfm. Total air volume is 325,000 acfm. Average air-to-cloth ratio is 14 to 1. The bag filters are equipped with manometers to measure pressure drop across the bags to aid in operating and maintenance.

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The collected dust is transferred by a screw conveyor into a central collection pipe and is conveyed by air pressure to one of two collection bins. The collected dust is hauled away by truck.

5.0 Performance Evaluation

5.1 Inspection and Maintenance Program

One man spends full-time inspecting and servicing the fabric filters. Inspection and maintenance procedures used are those recommended by the manufacturer. According to the service man the filters have operated over the years with few problems. When the residual pressure drop across the bags reaches six inches of water, the bags are removed and cleaned by an outside contractor and returned to service. This happens about twice a year. The dust has a tendency to build up within the bag fabric. About five percent of bags are torn during this process each year. Another problem is the screw conveyor at the bottom of the filter, which plugs fairly frequently, perhaps once every two weeks, for all filters. When this happens, the conveyor must be taken apart and cleaned. About once a year a bearing on a motor or fan burns out. These bearings are usually repaired without allowing any excess emissions to the atmosphere.

5.2 Emissions Data

No stack tests have been made at this source.

Emissions have been estimated from other data supplied by the company.

1977-1978	estimated emissions:	300 lb/day
1970	estimated emissions:	4300 lb/day

The company estimated that weekly they are hauling away about 120,000 lbs of dust that is collected by all of the fabric filters. At 99 percent efficiency there would be 1200 lb/week escaping to the atmosphere. Also it is estimated that another 1000 lb/week could be escaping as fugitive emissions from such a large operation. These two emission figures add up to about 300 lb/day.

Emissions in 1970 were estimated to be 30,000 lb/week, on the basis of the following information supplied by the company. Grain handling at this facility in 1970 was about one-third of the current rate, which would indicate that about 40,000 lb/week were escaping from the operations. However, the cyclones in use at that time were collecting some dust which was estimated to be about 10,000 lb/week. Thus the figure of 30,000 lb/week or 4300 lb/day emissions to the atmosphere is estimated for 1970.

6.0 Cost Data

Capital Cost:	$750,000 accumulated cost since 1970. At 1977 prices the capital cost would be greater than $1 million.
O & M cost:	No data are available from source $250,000 per year is estimated from the following data: Two men full-time for inspection and maintenance, 1075 hp total for motors on fans and compressors (2¢/kwh), and $30,000 for supplies and other expenditures.
Spare parts inventory:	$10,000-$15,000, estimated by company. Spare parts include one motor and blower, bearings, bags, clamps, and solenoid valves for pulse jet collectors.

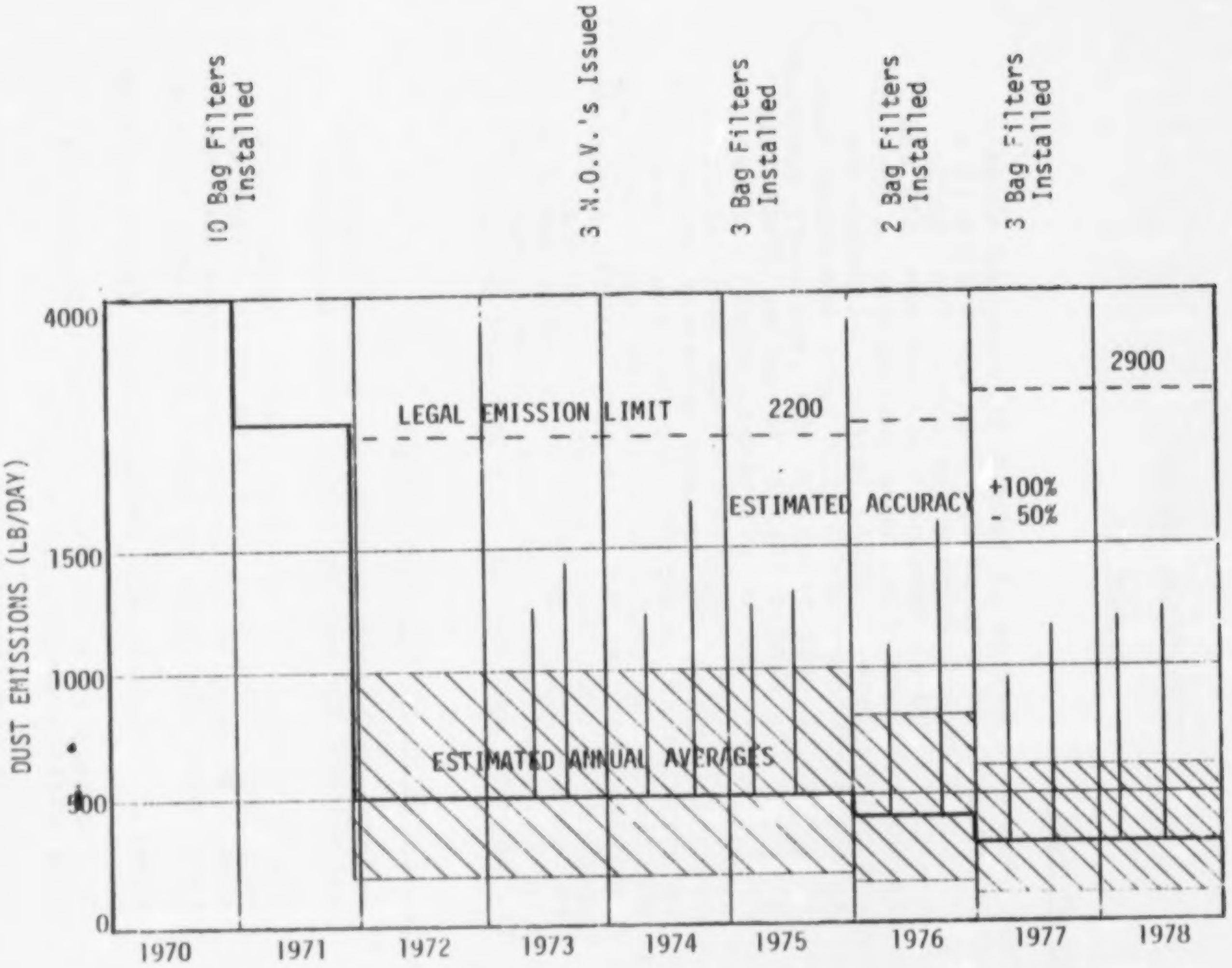

Figure 36-1. Reverse air jet bag filters. Nine year emission profile.

INSPECTION REPORT

SOURCE 37

1.0 Summary of Visit

This company operates 15 fabric filters and three cyclones to control dust emissions from operations at a large grain handling and storage facility. The fabric filters were installed at various times between 1970 and 1978 to replace cyclones which were ineffective in controlling dust emissions below visible levels. Although the company has operated under the Agricultural exemption rule, a number of citations were issued by the regulatory agencies in the mid-1970's for excess visible emissions (TACB Rule 5). With the installation of additional fabric filters in 1978 the source attained compliance to the satisfaction of the regulatory agencies. The company spokesman stated that without the agricultural exemption the firm would need to spend an additional four million dollars to comply with air pollution emission regulations. The agricultural exemption allows companies that handle or process agricultural products to use a weight-rate schedule of emissions or an alternate method approved by the TACB. This company has applied for an alternate method, but approval is still pending.

2.0 Chronology of Source/Agency Interaction

1970-1973	Several citations were issued by the regulatory inspectors for excess visible dust emissions.
1974	The TACB annual inspection report stated there were heavy dust emissions from grain unloading area. At regulatory agency insistence the company began replacing cyclones with fabric filters.
1975	Several cyclones were replaced with fabric filters.
1976	On February 10th the facility had a disastrous fire costing about $1.0 million.
1976	Following the fire the company replaced all but four cyclones with fabric filters.

1977	The TACB annual inspection report stated that all fabric filters were in place and controlling emissions. Excess emissions were observed at ship and barge loading docks, where duct work was already in place to install another filter.
1977	Federal EPA Region VI personnel inspected the facility and noted three excess dust emission sources. The agency requested emission data. No measurement data were in the TACB region file.

3.0 Plant and Process Description

This plant is a large grain storage and handling facility with an annual throughput capacity of 150 million bushels. The plant has unloading facilities for trucks and rail cars, and loading facilities for ships, barges, and rail cars. Sources of dust at this facility are many; rail car and truck unloading, conveyer belts, storage bins, elevator legs, turn heads, and weighing operations.

This company has 15 fabric filters and three air dyne cyclone type systems installed throughout the plant. A table is attached showing each filter unit. Cyclones were installed when the plant was built in 1967 at a capital cost of $1.4 million. These cyclones did not control emissions very well and the company replaced all but four with fabric filters by 1977.

Truck and rail car unloading operations are very dusty when not properly controlled. These facilities require hoods above the cars and exhaust air vents beneath the cars near the grain bins for proper control. Grain is moved by conveyor belts and an elevator to the top of the head house from which it flows by gravity to distributor heads and into storage bins or to weighing and loading facilities. All of these operations require dust control equipment.

4.0 Air Pollution Control Equipment

This company has 15 Carter-Day fabric filters within the facility. These filters range in size from 24 bags 84 inches long to 72 bags 96 inches long. Air volumes range from 6000 to 20,000 acfm with an average air-to-cloth ratio of 12 to 1. Collection efficiency is 99 percent for dust particles two microns in diameter or larger. These filters collect 30 tons of dust per week.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

The company's central engineering dept. has written a dust collection system operating manual for use at all company facilities. This manual is relatively complete containing definitions, typical system diagrams, problem areas, inspection procedures, fabric filter diagrams, and instrument descriptions. Differential pressure gauges, bearings, belts, motors, fans, torn bags, and visible emissions are checked daily. Three men are required for inspections and maintenance. Most of the bags must be changed yearly because high humidity causes the bags to become encrusted. Torn bags are replaced immediately, requiring two to three hours. Replacement of a fan motor requires six to eight hours. In 1977, 15 motors were replaced (rotary valve and fan motors). Also 8 rotary valves were replaced in one 12-month period.

5.2 Emissions Data

No stack tests or ambient air measurements have been made at this facility. No emission inventory forms were in the TACB files, probably because of the Agricultural exemption.

The facility is regulated by TACB Rule 5 concerning excess visible emissions and odors.

6.0 Cost Data

a. Capital cost: $1.4 million since 1971

b. O & M cost: $200,000 annually (partly estimated)

Company data: Labor $ 3,000/month
Parts $ 7,000/month
$10,640 x 12 = $127,680

Total hp for fan motors = 700 hp @ $100/hp/yr = $70,000
Total = $197,680

c. Spare parts: No cost data available

Inventory includes: rotary air lock valves, rotary valve motors, motors and reducers on fans, positioners for reverse air, duct pipe, baskets, rods, bags, tops and lower cone chambers, bearings, etc.

INSPECTION REPORT

Source 38

1.0 Summary of Visit

The facility is a fertilizer manufacturing complex producing ammonium phosphate fertilizers of varying composition. The complex is currently in general compliance with air quality control standards. Much of the air pollution control equipment was installed as the result of notifications of violation and/or court orders to reduce emissions. The plant covered in this report treats wet phosphoric acid with ammonia to produce ammonium phosphates of varying nitrogen and phosphorous content. The total plant capacity is 170,000 tons per year.

2.0 Chronology of Source/Agency Interaction

1970-1973	A number of N.O.V.'s were issued to the source by the city health department and the TACB during this period.
1973	June. A court order obtained by the TACB in 1973 required compliance by December 31, 1973.
1974	Three venturi scrubbers were installed at this source which brought the source into compliance with regulations and the court order.
1974-1977	One or two N.O.V.'s were issued by the city agency and the TACB each year for excess particulate emissions which were usually caused by process upsets.

3.0 Plant Description

Ammonia, phosphoric acid, and sulfuric acid are blended to produce monoammonium and diammonium phosphates. Potash (agricultural grade potassium chloride) is also added to certain products in which potassium values are desired. To give the fertilizer product the appropriate physical and mechanical properties, small amounts of fatty acid, anti-caking agent, reclaimed motor oil, and urea are also blended into the product. The product is granulated, dried, and screened to obtain the desired particle size.

Pollutants inherent to this operation include fertilizer dust and ammonia gas.

4.0 Air Pollution Control Equipment

In 1967, three UOP scrubbers and ten cyclones were installed. Although the actual efficiency for these scrubbers was better than 90 percent, operating experience demonstrated that the UOP scrubbers were not adequate for the process. They were shut down every three days for scheduled cleaning. In addition, there were unscheduled outages due to plugging of nozzles and spray heads.

In 1974 three new scrubbers and a fabric filter were installed. The new scrubbers were in series with the existing scrubbers. The scrubbers were manufactured by Polycon and had a design and actual efficiency of better than 95 percent. The new equipment allowed the plant to operate well within the standards established by the TACB.

5.0 Performance Evaluation

Based upon data submitted by the company to the TACB, this plant has the capability to maintain particulate emissions well within established limits. There have been occasional citations for opacity violations; most violations occurring when formulations are changed, since each grade of fertilizer has different scrubber operating requirements. These excursions have been mainly attributed to operator error rather than to control equipment limitations. A significant factor is that the product is hygroscopic and tends to stick to walls when the plant is shut down. It is then released when the plant is again started.

Stacks are not equipped with continuous monitors. Stack analyses are performed as required by outside consultants, although the company has in-house capability and equipment. An operating log is kept for repairs, but repairs to comply with environmental regulations are not filed separately.

5.1 Maintenance

The maintenance department is operated as if it were a separate company. A charge is made against each department receiving services and credited to the maintenance department. The revenue credited to the maintenance department is expected to exceed the expense. Records for pollution control equipment maintenance are not kept separately. Special problems with pollution control equipment include:

1. The original UOP scrubbers installed in 1967 are not suitable for the process. The mist eliminator vanes are inadequate so that particulates are discharged to the atmosphere. These scrubbers are down every three days for cleaning.
2. Some problems have been encountered with respect to reentrained dust which is carried from the cyclones into the scrubbers.

Other problems often encountered include pump outages and plugging of nozzles, spray heads and ammonia scrubbers.

5.2 Emission Data

The following emission data were taken from the emission inventory reports submitted to the TACB for 1970 through 1975.

	1970	1971	1972	1973	1974	1975
Particulate Emissions, lb/hr	97	133	155	90	--	5
Regulatory Limit, lb/hr	107	105	102	102	--	103

These data are plotted in Figure 38-1 as annual emission rates.

6.0 Cost Data

a. Capital cost: $826,000 (1974)

b. O & M cost: Not available

Table 38-1 shows air pollution control operating costs for the entire fertilizer plant. Costs are allocated for depreciation, labor, equipment leasing and material, supplies, etc.

c. Spare Parts

All parts are catalogued. No distinction is made between parts used for production equipment and for pollution control equipment. Doing this would be difficult because many items such as pumps are used for production processes as well as for pollution control. A lot of effort is made to standardize equipment.

Parts are charged out from inventory on a current-cost basis rather than on the basis of actual purchase costs.

Table 38-1: Facility Pollution Control Cost Summary

Pollution Control	1972	1973	1974	1975	1976
Operating Cost, ($ x 10^6)	Not given	1197	1808	2573	2610
Percent for control of air pollution	77	43	52	36	36
Air pollution control cost ($ x 10^6)	--	515	940	926	940
Percent allocated to depreciation	34	54	53	21	20
Percent allocated to labor	39	14	15	18	3
Percent allocated to equipment leasing	3	2	2	--	--
Percent allocated to materials, supplies, etc.	24	30	30	61	77
Cost per ton of product ($)	--	7	11	15	15

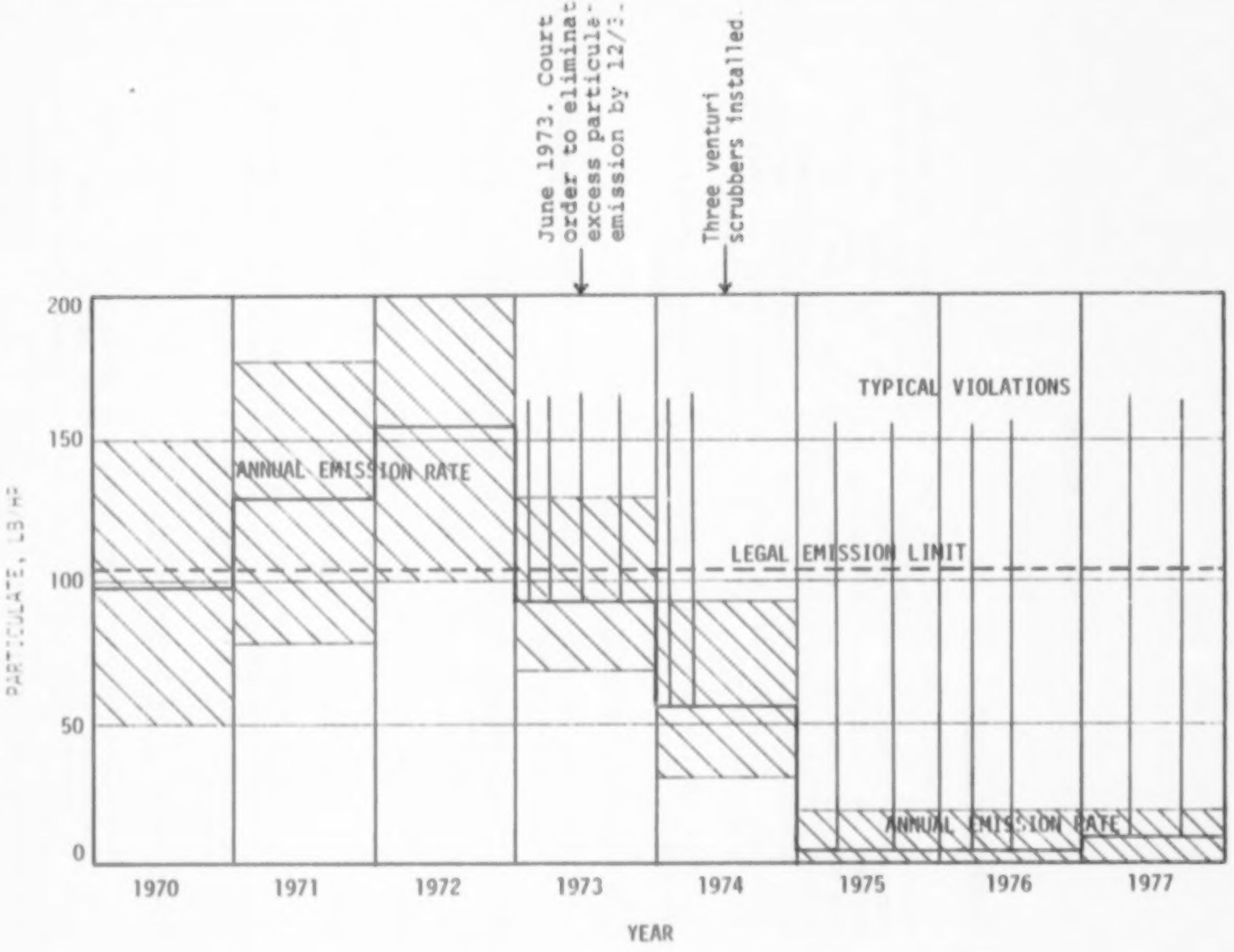

Figure 38-1. Venturi scrubbers at an ammonium phosphate plant. Eight year emission profile.

INSPECTION REPORT

Source 39

1.0 Summary of Visit

This plant has operated two spray scrubbers in series since 1970 to control particulate emissions from an ammonium phosphate dryer. Prior to 1970 a single scrubber was borderline in meeting regulation limits. The addition of the second scrubber in series brought the source well within limits during normal operation. These scrubbers have operated very well over the years without any major problems. When excessive emissions occur, this is usually due to process upsets rather than scrubber failures.

The drying process is subject to frequent upsets, especially when the fertilizer grade is changed.

2.0 Chronology of Source/Agency Interaction

1966-1970	The source had considerable problems in meeting opacity regulations.
1970	A second scrubber was added in series. This addition reduced emissions to within regulations on a continuing basis.
1971-1976	One to three N.O.V.'s were issued by the city agency for opacity violations each year.
1977	No N.O.V.'s were issued.
1978	Six N.O.V.'s were issued during first 10 months of the year due to process upsets that were caused by a higher production rate.

3.0 Plant and Process Description

This plant manufactures ammonium phosphate fertilizer from phosphoric acid and ammonia. Other parts of the facility manufacture phosphoric acid and sulfuric acid which are used in the process. Phosphoric acid is produced by treating phosphate rock with sulfuric acid. Maximum plant capacity is 650 ton/day of finished fertilizer, whereas normal throughput is about 500 ton/day. In the ammonium phosphate process phosphoric acid is treated with ammonia in a reactor, and the resulting ammoniated slurry flows onto a rolling bed of solidified ammonium phosphate in a rotary granulator where the ammoniation reaction is completed. The ammonium phosphate is dried in a rotary dryer and passed to screens where proper size material is retained as product; fines are recycled to the granulator. A flow diagram is shown in Figure 39-1.

4.0 Air Pollution Control Equipment

Two scrubbers in series remove ammonia and particulates from the rotary dryer effluent gas. The second scrubber was added in 1970 after the first one failed to control particulates satisfactorily. The second scrubber, made by the Joy Manufacturing Co., increased particulate removal efficiency to 90-95 percent and reduced the particulate emissions and opacity to well below regulatory requirements. Gas flow rate is 60,000 acfm, and the water recirculation rate is 300 gpm. Phosphoric acid (28 percent) is recirculated in the first scrubber to increase the ammonia removal efficiency.

These scrubbers have generally operated without major problems. However, daily cleaning of spray nozzles is required. This is accomplished without shutting down the scrubber or causing excess emissions. Recirculating pumps need repairing or replacing about once every four months. A continuous opacity monitor cannot be used because of entrained water droplets. An increase in opacity violations, as a result of recent high production rates indicates that the scrubbers may be inadequate for continuing compliance at these high production rates. The company would like to increase the efficiency of the scrubbers but has not yet determined a feasible method to do so.

5.0 Performance Evaluation

5.1 Maintenance and Repairs

Maintenance on these scrubbers is performed as needed. No major problems have developed with these scrubbers. The biggest problems are plugging of spray nozzles and recirculating pump wear. The scrubbers are inspected daily and plugged spray nozzles are cleaned. Pump repairs are required about every three months.

These scrubbers are fairly easy to keep in operation a high percentage of the time. As yet both scrubbers have never failed at the same time; thus at least a reasonable removal efficiency has been maintained at all times. The process is shut down every two weeks to clean nozzles and scrubbers thoroughly, and to make repairs to pumps and other items.

5.2 Emissions Data

No stack tests were performed on this source prior to 1973. Assuming that the original scrubber had a control efficiency of about 50 percent, we estimate that emissions previous to the installation of the second scrubber were 60 lb/hr. Compliance tests were conducted by TACB on January 9, 1973. Results of those tests were as follows:

Date	Test	Actual Emission, lb/hr	Allowable Emission, lb/hr
Jan. 1973	1	9.83	48.0
Jan. 1973	2	11.00	47.0
Jan. 1973	3	8.84	54.0
Jan. 1973	4	11.60	49.0
Avg.		10.30	49.5

The company also performed several stack tests in the period 1973 to 1977. Results are tabulated as follows:

Date	Actual Emission, lb/hr
06/15/73	13.0
09/12/73	4.4
10/11/73	12.2
Avg.	9.9
1/15/75	7.0
06/95/75	5.0
09/14/76	17.7
04/21/77	12.3
Avg.	10.5

These data are plotted in Figure 39-2 along with our estimated emission profile.

6.0 Cost Data

a. Scrubber capital cost: $80,000 (1970)
b. Scrubber O & M cost: 27,600 (1977)
c. Spare parts inventory: 9,000
d. O & M cost for entire process: $1.0 million (1977)
Scrubber O & M as percent of Process O & M: 2.8

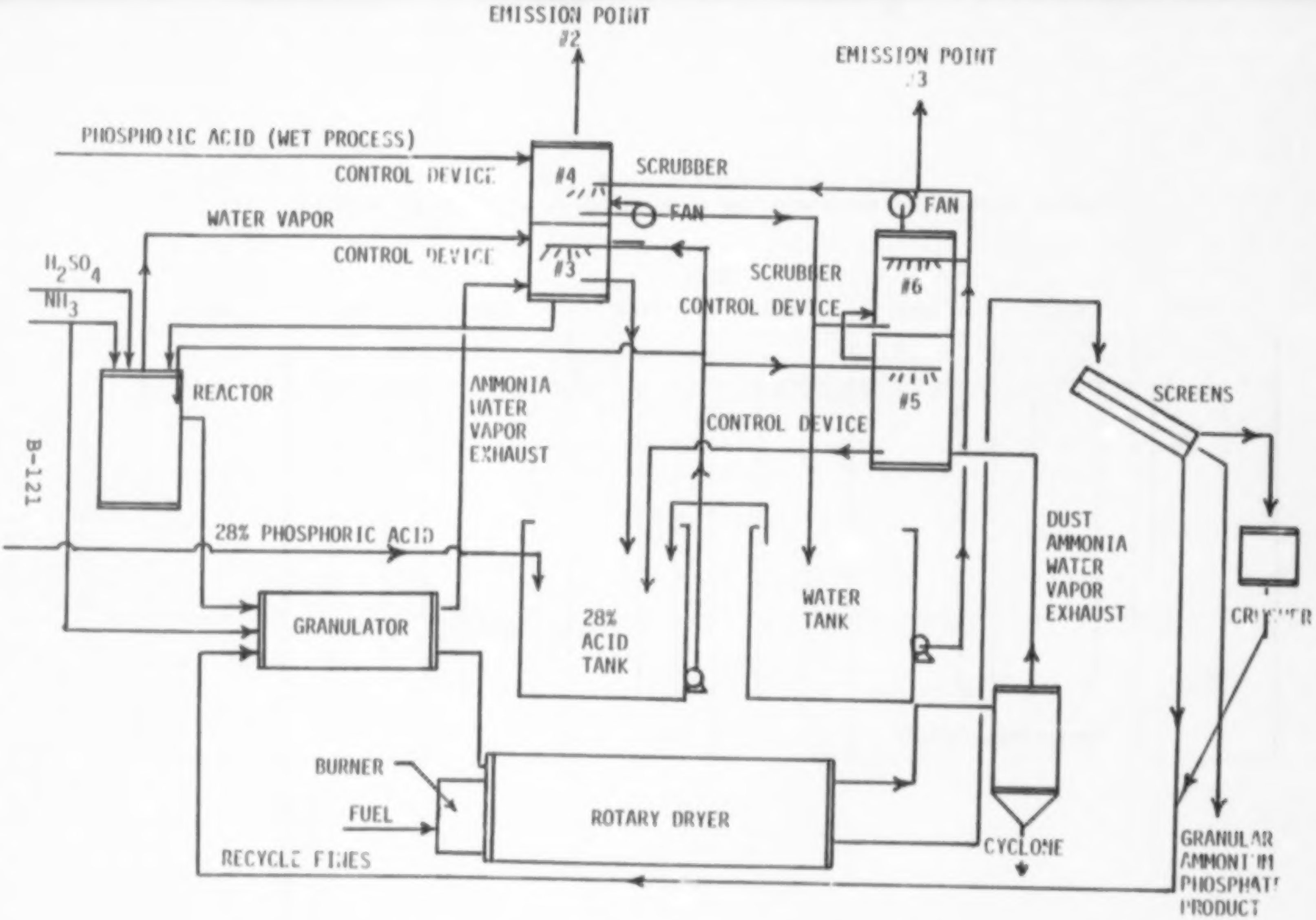
EMISSION POINT #2
EMISSION POINT #3
PHOSPHORIC ACID (WET PROCESS)
CONTROL DEVICE
#4
SCRUBBER
FAN
WATER VAPOR
CONTROL DEVICE
#3
H_2SO_4
NH_3
SCRUBBER
FAN
#6
CONTROL DEVICE
REACTOR
AMMONIA
WATER
VAPOR
EXHAUST
#5
SCREENS
CONTROL DEVICE
28% PHOSPHORIC ACID
DUST
AMMONIA
WATER
VAPOR
EXHAUST
WATER TANK
28% ACID TANK
CRUSHER
GRANULATOR
BURNER
FUEL
ROTARY DRYER
CYCLONE
RECYCLE FINES
GRANULAR
AMMONIUM
PHOSPHATE
PRODUCT

Figure 39-1. Ammonium phosphate process

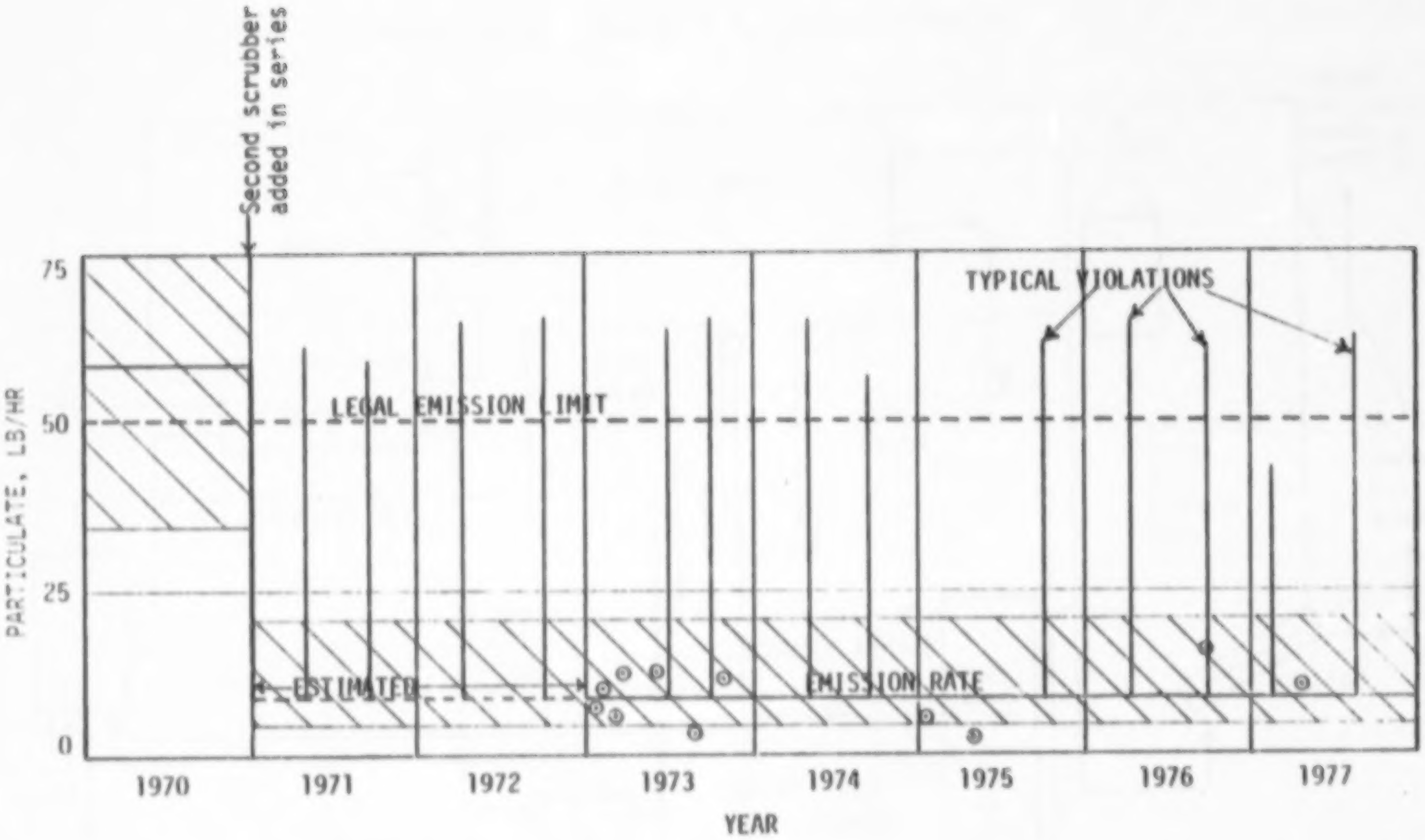

Figure 39-2. Spray scrubbers at ammonium phosphate dryer. Eight year emission profile.

INSPECTION REPORT

Source 40

1.0 Summary of Visit

This company applies coal tar enamel to steel pipe. It is a small operation employing 25 people and has not drawn a great deal of attention from regulatory agencies.

There are three operations in this plant which generate air emissions. Those operations are heating and storing coal tar enamel at 500° F, shot blasting the pipe to prepare it for coating, and applying the enamel. This report is concerned with the enamel application operation. Until recently the facility consisted of two plants. Plant No. 1 was destroyed by fire, and a new facility is under construction. When the new plant is completed, Plant No. 2 will be dismantled.

2.0 Chronology of Source/Agency Interaction

An annual inspection was conducted by the city in October 1977. Several complaints have been received about emissions from other parts of the plant. The agency has not documented the continuing noncompliance problem that exists.

3.0 Plant Description

Coal tar enamel is received as a solid. It is placed in gas-fired open-top kettles, melted, and held at 500° F. The pipe is prepared for the application of enamel by shot blasting the surface. The shot blast machine is vented through a fabric filter. When the enamel is applied by pouring, the pipe is in a hood that is vented to a water scrubber.

4.0 Process and Control Equipment Evaluation

The present water scrubber has a flow rate of 9000 cfm. The water rate is 200 gpm. The hoods capture about 80 percent of the emissions and the scrubber efficiency is estimated at about 90 percent.

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5.0 Performance Evaluation

5.1 Maintenance and Repairs

Standard practice has been to keep a spare pump and nozzles on hand. At one time a motor burned out. The plant continued to operate while repairs were being made. Repairs are made as required. The small plant does not have a maintenance department, and no specific budget is established for this air pollution control system.

5.2 Estimated Emissions

Estimates have been prepared by the engineering firm that has designed the new facility. Hood capture efficiency was estimated to be 80 percent and scrubber efficiency was estimated to be 90 percent. The present enamel application facility operates eight hours per day. Estimated particulate emissions are 1130 pounds per day (fugitive) and 450 pounds per day (stack). These emissions are respectively four times and ten times the regulatory limit.

5.3 Comments

A new facility has been designed to restore needed production capacity and to comply with environmental regulations. A new scrubber and ventilation system has been designed to allow the company to comply with regulations. The new facility should be operating in the near future.

6.0 Costs

Very little cost data were furnished. The new scrubber system will cost $10,000. The orginal scrubber system was estimated to have cost $5000 when it was installed in 1968. A pump motor was once replaced; annual repair costs of about $400 were indicated.

Some costs are difficult to assign. The new water scrubber system is an example. It could possibly be economically justified on a basis of increased production efficiency, reduced employee turnover etc., completely aside from environmental considerations. On the other hand, the total cost could be justified in terms of meeting air pollution control regulations.